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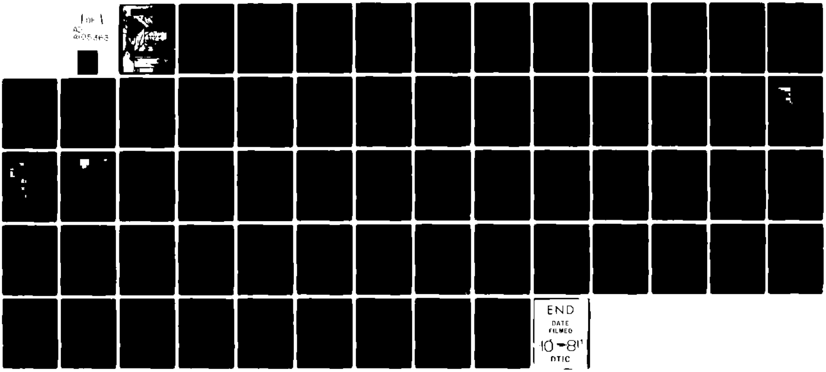

SEDIMENT TRANSPORT IN THE TANANA RIVER NEAR FAIRBANKS, ALASKA, 1977-79

U. S. GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS 81-20

Prepared in cooperation with
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Suspended-sediment- and bedload-transport rates for the Tanana River near Fairbanks, Alaska, can be related to water discharge, and annual sediment loads can be computed using these relations. For a site near Fairbanks, the average annual (1974-79) load is 24 million metric tons of suspended sediment and 321,000 metric tons of bedload. Upstream, near North Pole, the average annual load is 20.7 million metric tons of suspended sediment and 298,000 metric tons of bedload. For both sites bedload is usually 1 to 1.5 percent of suspended-sediment load. Particle-size distribution for suspended sediment is similar at Fairbanks and North Pole. Median particle size is generally in the silt range, but at some low-water discharges, it is in the very fine sand range. Median particle size of bedload near North Pole is generally in the gravel range, but at some low transport rates, it is in the medium sand range. In 1977 median bedload particle size was comparable at the two sites, but in 1978 the median size was markedly smaller at Fairbanks. In 1979 generally coarser material was transported at both sites, but the difference in bedload particle size was even greater between the sites. At both locations and all water discharges and sediment-transport rates, suspended-load particles are significantly smaller than bedload particles. At North Pole in 1979, median bed-material particle size was in the coarse gravel range; at Fairbanks it was in the medium gravel range in the main channel but in the fine sand range in the overflow part of the channel.

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NEAR FAIRBANKS, ALASKA, 1977-79

11 April 82

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CONVERSION TABLE

The following factors may be used to convert the International System of Units (SI) used herein to the inch-pound system of units.

Multiply SI units	by	to obtain inch-pound units
millimeter (mm)	0.0394	inch (in.)
meter (m)	3.281	feet (ft)
kilometer (km)	0.621	mile (mi)
kilogram (kg)	2.205	pound (lb)
megagram or metric ton (Mg)	1.102	ton, short (t)
cubic meter per second (m^3/s)	35.311	cubic foot per second (ft^3/s)
kilogram per meter (kg/m)	0.672	pounds per foot (lb/ft)

Suspended-sediment concentrations are given only in milligram per liter (mg/L) because these values are (within the range of values presented) numerically equal to equivalent values expressed in parts per million.

LIST OF SYMBOLS

A	-	Cross-sectional area of flow (m^3)
D	-	Mean depth of flow (m)
GH	-	Gage height (m)
Q	-	Discharge or flow rate (m^3/s)
S	-	Slope (m/m)
V	-	Mean velocity of flow (m/s)
W	-	Surface width of flow (m)
d	-	Particle size (mm)
G_B	-	Bedload-transport rate (Mg/day)
G_S	-	Suspended-sediment transport rate (Mg/day)
r	-	Correlation coefficient

SEDIMENT TRANSPORT IN THE TANANA RIVER NEAR FAIRBANKS, ALASKA, 1977-79

By Robert L. Burrows, William W. Emmett, and Bruce Parks

ABSTRACT

Suspended-sediment- and bedload-transport rates for the Tanana River near Fairbanks, Alaska, can be related to water discharge, and annual sediment loads can be computed using these relations. For a site near Fairbanks, the average annual (1974-79) load is 24 million metric tons of suspended sediment and 321,000 metric tons of bedload. Upstream, near North Pole, the average annual load is 20.7 million metric tons of suspended sediment and 298,000 metric tons of bedload. For both sites bedload is usually 1 to 1.5 percent of suspended-sediment load.

Particle-size distribution for suspended sediment is similar at Fairbanks and North Pole. Median particle size is generally in the silt range, but at some low-water discharges, it is in the very fine sand range.

Median particle size of bedload near North Pole is generally in the gravel range, but at some low transport rates, it is in the medium sand range. In 1977 median bedload particle size was comparable at the two sites, but in 1978 the median size was markedly smaller at Fairbanks. In 1979 generally coarser material was transported at both sites, but the difference in bedload particle size was even greater between the sites. At both locations and all water discharges and sediment-transport rates, suspended-load particles are significantly smaller than bedload particles.

At North Pole in 1979, median bed-material particle size was in the coarse gravel range; at Fairbanks it was in the medium gravel range in the main channel but in the fine sand range in the overflow part of the channel.

INTRODUCTION

To facilitate design and operation of engineering structures on the Tanana River and to regulate gravel extraction from the river near Fairbanks, the U.S. Army Corps of Engineers, Alaska District, requested that the U.S. Geological Survey collect and evaluate sediment-transport and river-hydraulic data during periods of principal runoff, beginning in 1977. Data-collection sites were established at the U.S. Geological Survey gaging station, Tanana River at Fairbanks (station 15485500), and at an unnumbered miscellaneous site, Tanana River near North Pole, approximately 24 km upstream from the Fairbanks station (fig. 1). Streamflow data for the Fairbanks station are published annually in the U.S. Geological Survey's "Water Resources Data for Alaska."

Previous reports by Emmett, Burrows, and Parks (1978) and Burrows, Parks, and Emmett (1979) presented results of data collected in 1977 and 1978 respectively. The present report includes all data collected through 1979; it supersedes the earlier reports. Each future data report on sediment transport

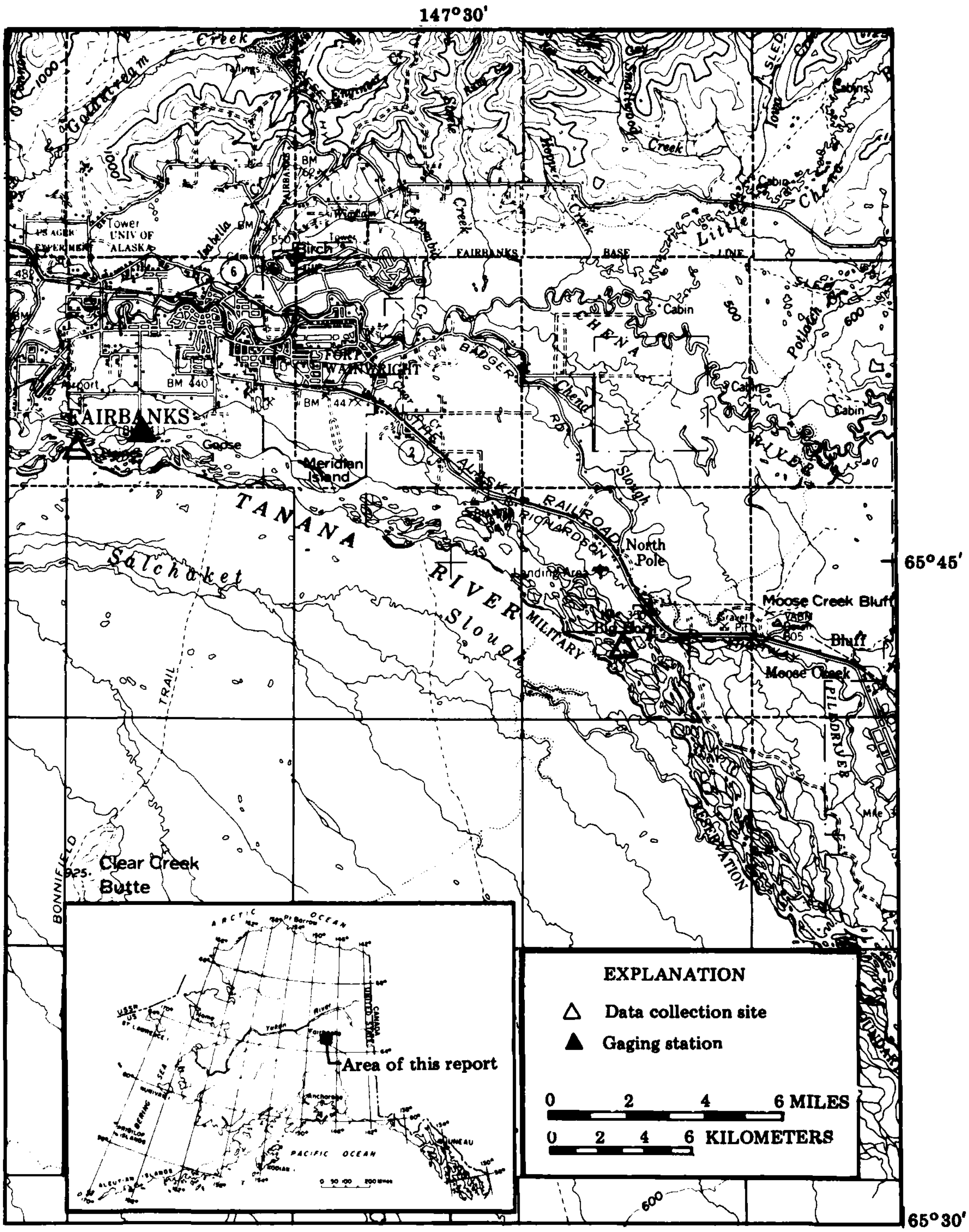

Figure 1.--Location of Tanana River and data-collection stations.

in the Tanana River will contain data for only one year. All data in this report are presented in the International System of Units; inch-pound values previously published have been converted to metric units using the factors in the table on page v. Data are presented in tables and graphs and most of the text is devoted to explaining them. The primary purpose of this report is to provide the Corps of Engineers information that is pertinent to their design computations and regulation of gravel extraction.

The study program is funded by the Corps of Engineers through a cooperative agreement with the U.S. Geological Survey. All fieldwork and compilation of data were done by the Geological Survey. Most laboratory analyses of particle size and suspended-sediment concentrations in 1977 were done by the Corps of Engineers. Laboratory analyses for the April 1977 samples and for those collected since October 1977 were made by the Geological Survey.

INSTRUMENTATION AND DATA COLLECTION

Gage heights during the open-water season at the Fairbanks station were documented by a continuous trace on an analog recorder. The continuous trace was analyzed to determine daily mean gage heights and corresponding daily mean discharges. During the winter-flow period, values of daily mean discharge were estimated using periodic discharge measurements and climatological data, and by correlation with data available from the gaging station Tanana River at Nenana.

Measurements of depth and velocity and collection of sediment were done from a boat. Stationing on the cross section was determined using sextant readings on a base line while the boat's position was maintained by visual reference to the cross-section end markers.

Bed-material data in this report are from analyses of samples collected in September 1979. Samples were obtained at increments of 15 m across the active channel width at Fairbanks and North Pole. These samples represent the top 10-20 cm of the bed. Samples from exposed or shallowly covered bars were collected using a shovel. In channels with flow, samples were collected with either a hand-held (100-mm diameter) or a cable-suspended pipe dredge (200-mm diameter) while wading or from a boat.

A P-61 or a D-49 suspended-sediment sampler (Guy and Norman, 1970) was used to collect depth-integrated water samples for analysis of concentration and particle-size distribution of the suspended sediment. A Helley-Smith type bedload sampler with a 76.2 mm by 76.2 mm orifice (Helley and Smith, 1971) was used to collect bedload samples that enabled determination of bedload-transport rate and particle-size distribution of the bedload. The Helley-Smith bedload sampler has not been adopted by the U.S. Geological Survey as standard equipment; therefore, results obtained through its use cannot be certified for accuracy. However, the Geological Survey has described provisional methods for the use of the Helley-Smith sampler pending further research and testing. A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler (Emmett, 1980) indicated that no correction factor need be applied to the bedload data as collected. The sampler has been used with apparent success in other rivers that have bedload-

transport rates and bedload particle-size characteristics similar to those of the Tanana River (Emmett, 1976; Emmett and Thomas, 1978).

Most of the bedload samples were obtained at 15-m increments across the part of stream width where bedload transport occurs. Generally, this resulted in collection of 18 to 20 samples across the stream width. Sampling duration was 30 seconds at each location. For most traverses of the stream, each individual bedload sample was given equal consideration in the determination of average stream-wide transport rate. When duplicate samples were obtained at a given location, these sample data were averaged, and the average value used in the same manner as individual values. Samples collected at each end of the traverses were given the same consideration as other individual samples, regardless of the incremental width of channel associated with the samples collected near each bank.

SEDIMENT TRANSPORT AND HYDRAULIC DATA

To facilitate application of the sediment data in this report, appropriate hydraulic data are provided. Data for streamflow, hydraulic and channel geometry, and bed material allow empirical evaluation and interpretation of the sediment-transport data.

Streamflow Data and Channel Geometry

Table 1 presents a summary of discharge measurements made during the periods of sediment sampling on the Tanana River at Fairbanks. Cross-section data for several of the discharge measurements included in table 1 are plotted in figures 2-5. Cross sections in previous reports on the sites were depicted looking upstream; all sections are now shown in the more conventional downstream view.

During the period spring 1977 to fall 1979, which spanned three seasons of runoff, there was considerable shifting of bed material from the sand and gravel bar area to the thalweg (thread of maximum depth) and vice versa, sufficient to change the configuration of the cross section. This is illustrated in the top part of figure 5, which shows the change in channel shape from June 1977 to October 1979. In June 1977 the thalweg was near the south or left bank (about station 380 m), but by October 1978, deposition in this area and scour in the sand and gravel bar area had combined to shift the thalweg about 120 m toward the north bank (about station 260 m). This trend continued in 1979, and the thalweg in October 1979 was 45 m further towards the north bank (about station 215 m). The bar that emerged at the time of the October 1978 measurement had increased in exposed width at a similar stage in October 1979 by about 35 m. Most of the bar building has been on the right side. There was no flow in the small left channel at the time of the October 1979 measurement.

Much of this lateral shifting occurs during high water. Indeed, the channel changes shown in the bottom part of figure 5 occurred during the 1979 water discharge peak in a matter of 6 days. Significant shaping of the channel also seems to occur during the streamflow recession. That is, even as less transport of bed material occurs in the downstream direction, significant lateral

Table 1.--Summary of discharge measurements made during period of sediment sampling, Tanana River at Fairbanks

Date	Gage height (m)	Discharge (m^3/s)	Flow area (m^2)	Surface width (m)	Mean velocity (m/s)	Mean depth (m)
6-07-77	8.562	750	478	264	1.569	1.811
6-16-77	8.925	1,140	782	323	1.458	2.421
6-29-77	9.174	1,320	1,010	360	1.307	2.806
7-06-77	8.784	1,170	708	326	1.653	2.172
7-12-77	8.818	1,080	652	323	1.656	2.019
7-20-77	9.010	1,270	818	360	1.553	2.272
7-26-77	9.022	1,420	844	390	1.682	2.164
8-03-77	9.315	1,680	929	396	1.809	2.346
8-11-77	9.272	1,460	869	372	1.680	2.336
8-18-77	9.193	1,450	843	378	1.720	2.230
8-31-77	8.824	1,410	772	305	1.826	2.531
10-03-77	8.205	592	380	134	1.558	2.836
5-18-78	8.153	566	369	145	1.534	2.545
5-30-78	8.077	521	330	116	1.579	2.845
6-20-78	8.431	804	494	207	1.628	2.386
7-10-78	8.714	983	636	317	1.546	2.006
7-17-78	9.360	1,650	1,010	463	1.634	2.181
7-31-78	9.205	1,460	852	402	1.714	2.119
8-08-78	9.327	1,540	975	399	1.579	2.444
8-14-78	9.290	1,640	981	415	1.672	2.364
8-25-78	8.973	1,220	754	366	1.618	2.060
9-07-78	8.708	966	580	277	1.666	2.094
10-04-78	7.974	411	294	154	1.398	1.909
5-23-79	8.050	484	381	201	1.270	1.896
6-18-79	8.821	1,000	684	375	1.462	1.824
7-10-79	9.220	1,490	875	408	1.703	2.145
7-24-79	9.540	1,950	1,120	454	1.741	2.467
8-02-79	9.668	2,030	1,240	469	1.637	2.644
8-08-79	9.629	1,880	1,150	466	1.635	2.468
8-29-79	9.272	1,460	857	436	1.704	1.966
9-06-79	8.867	912	584	326	1.562	1.791
9-12-79	8.763	895	543	290	1.648	1.872
10-02-79	8.297	487	299	143	1.629	2.091

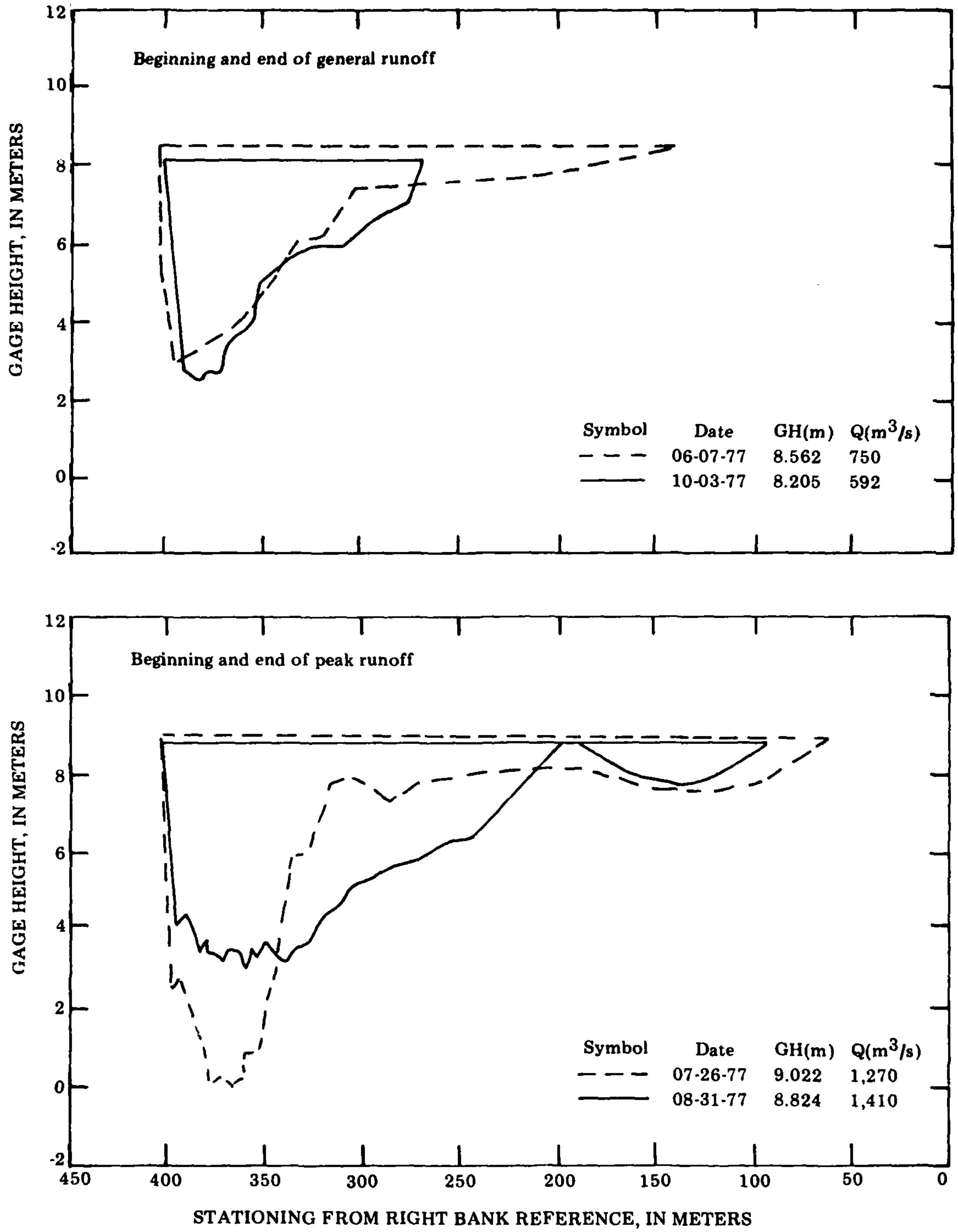

Figure 2.--Cross section of the Tanana River at Fairbanks, 1977.

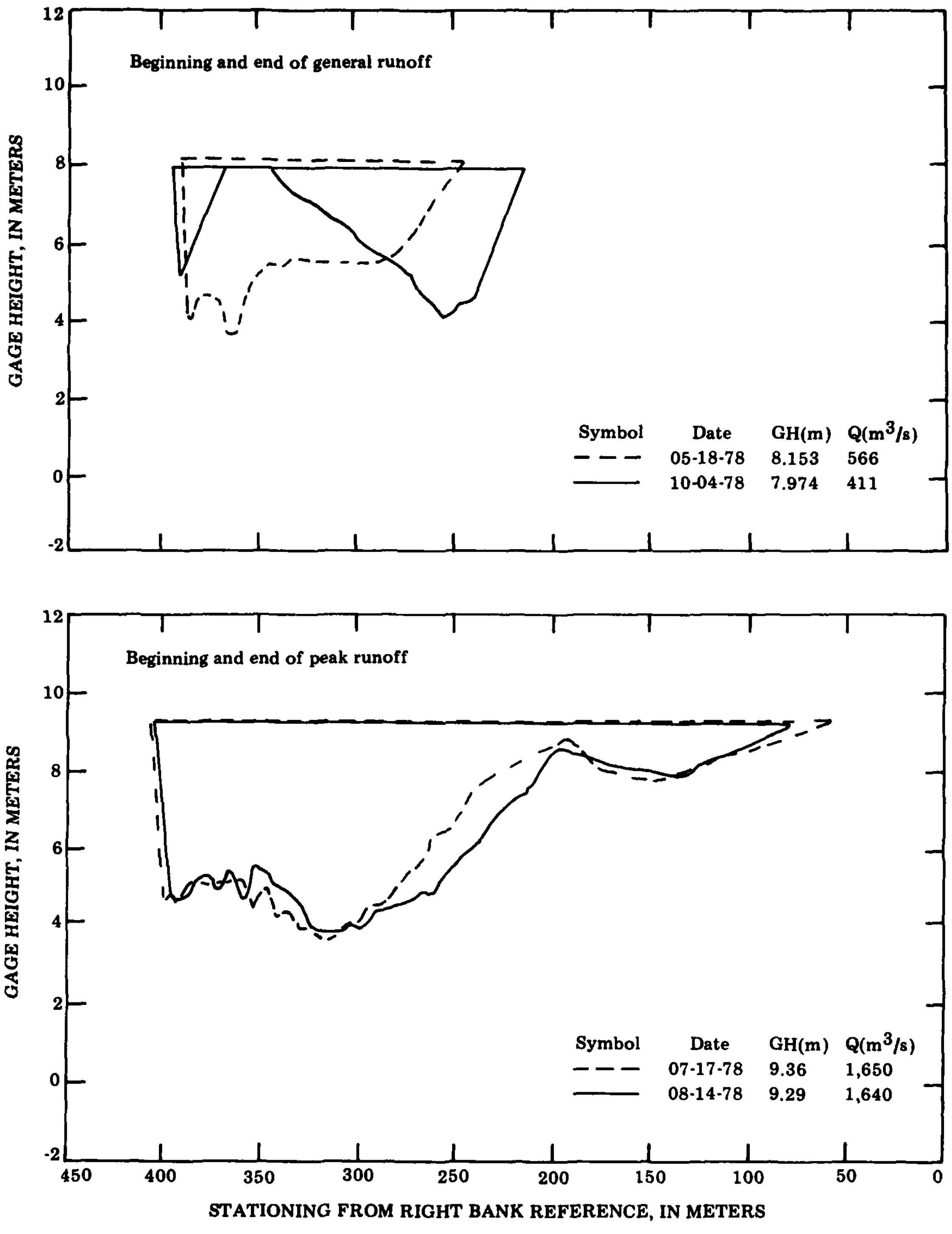

Figure 3.--Cross section of the Tanana River at Fairbanks, 1978.

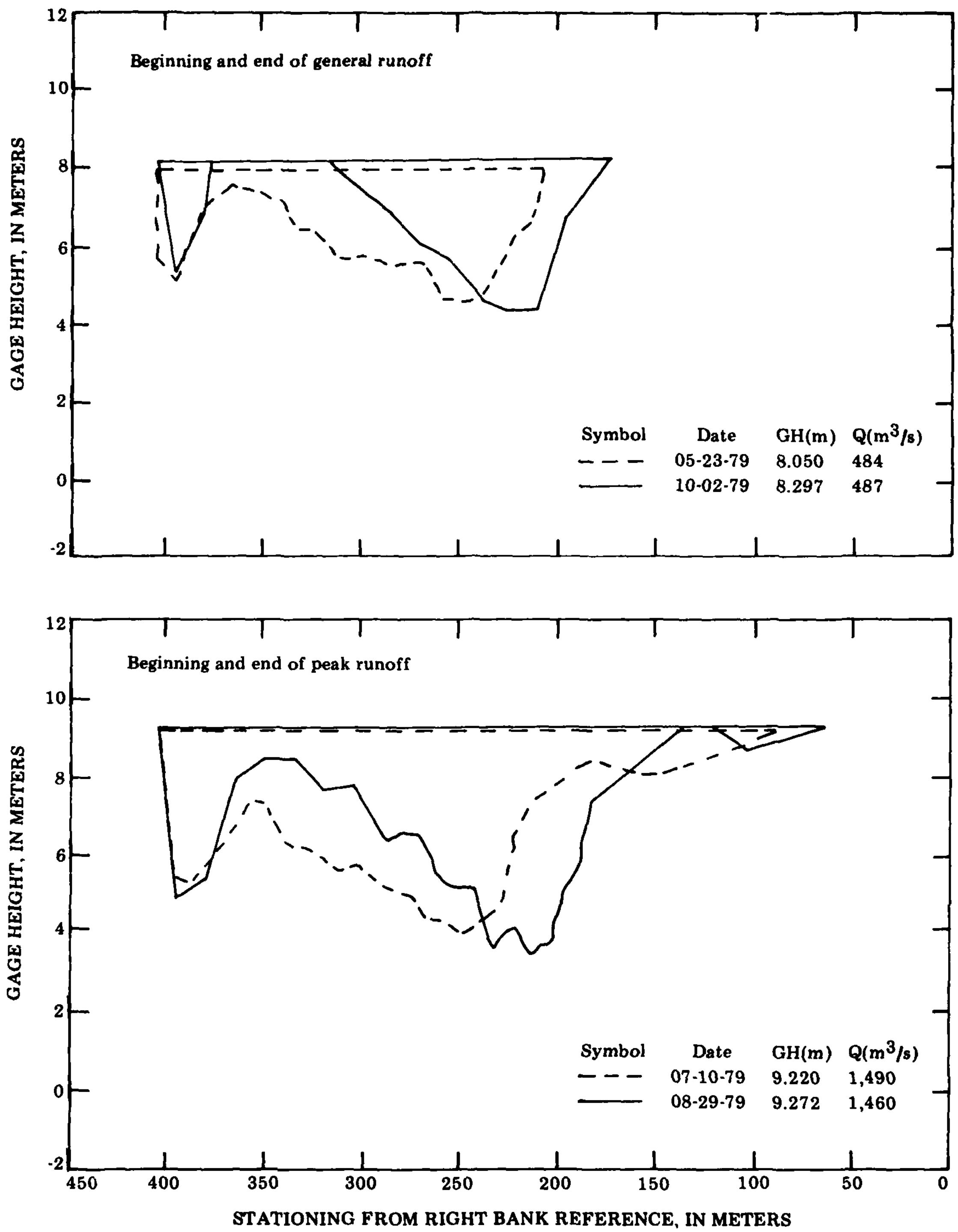

Figure 4.--Cross section of the Tanana River at Fairbanks, 1979.

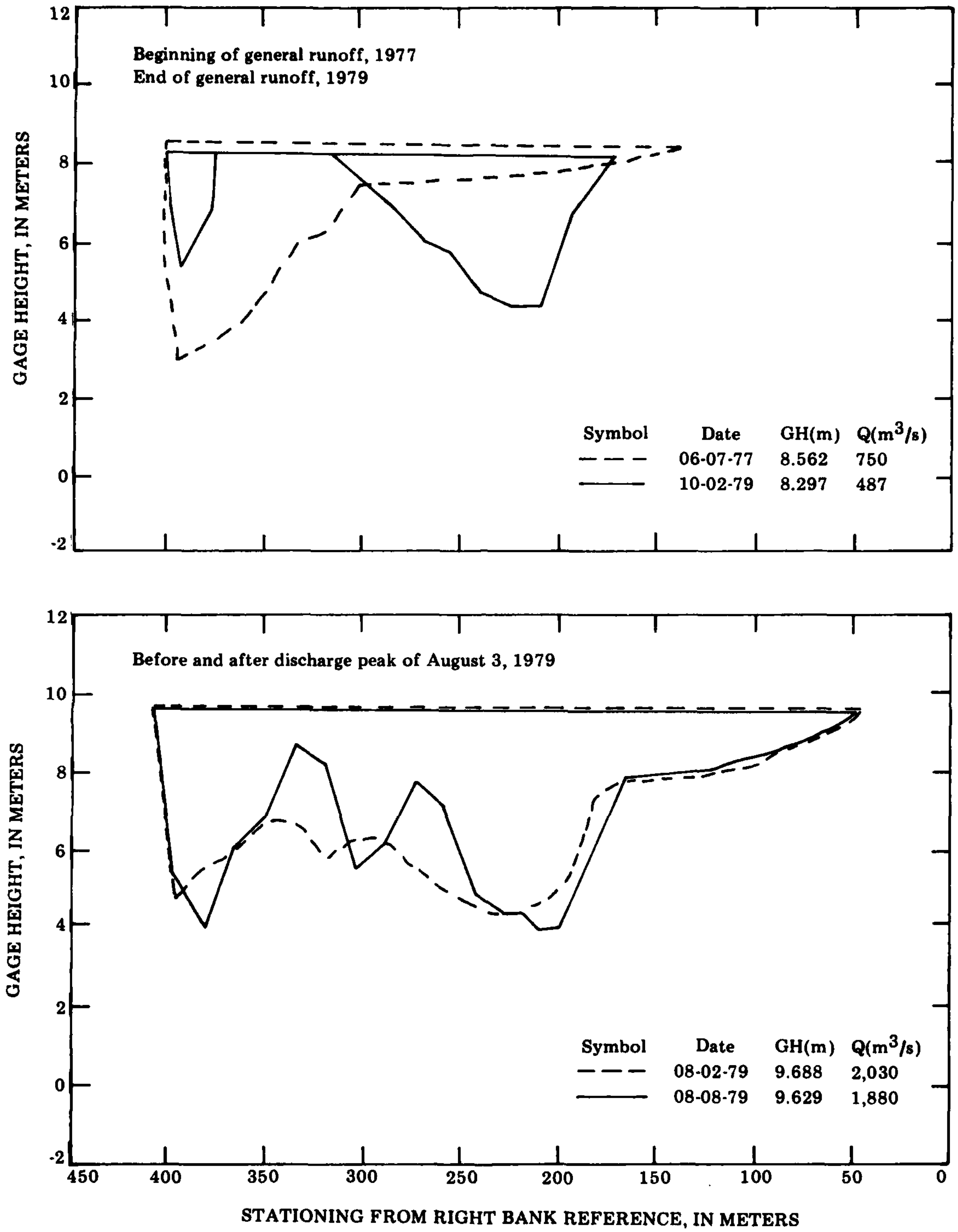

Figure 5.--Cross section of the Tanana River at Fairbanks.

shifting of the channel is still taking place. This is best illustrated by comparing the cross section of August 1978 (bottom of fig. 3) to the cross section of October 1978 (top of fig. 3), and noting the striking change that took place in less than two months.

Data from the discharge measurements in table 1 are plotted as at-a-station values of hydraulic and channel geometry (Leopold and Maddock, 1953) in figures 6, 7, and 8. Relations of gage height and velocity are considered river hydraulics, and those of area, width, and depth are considered channel geometry. The plotted data, in concert with the cross sections in figures 2-4, show that at river stages less than about 8.5 m (approximately 700 m^3/s), all of the flow is confined to deeper parts of the channel; above a stage of about 8.5 m, sand and gravel bars are submerged, and the surface width of the river increases rapidly. Because mean depth is a computed parameter (flow area divided by surface width), computed mean depth decreases with the rapid increase in surface width. This may imply that depth decreases with increasing discharge; in reality, the depth of the main body of water increases when discharge increases. Because of this anomaly, only the 1977-79 data in table 1 for discharges of more than 700 m^3/s were used to determine best-fit relations to the plotted data (figs. 6, 7, and 8). The technique used was a log-transformed least-squares linear regression. The resulting relations for gage height, width, depth, flow area, and velocity are shown with each graph.

Sufficient discharge measurements to determine at-a-station relations of hydraulic and channel geometry for the site near North Pole are not available.

Water-surface slopes were obtained in 1973 and 1975 as part of a special study by the U.S. Geological Survey in cooperation with the U.S. Army Corps of Engineers. For the Fairbanks site, the relation of water-surface slope indicates increasing values of slope with increasing discharge. The relation is:

$$S = 2.21 \times 10^{-4} Q^{0.115} \qquad (r^2 = 0.594)$$

For the location near North Pole, water-surface slope decreases with increasing discharge. The relation is:

$$S = 2.29 \times 10^{-3} Q^{-0.101} \qquad (r^2 = 0.758)$$

Shifts have occurred in the gage height, velocity, width, and depth relations from 1977 to 1978 and from 1978 to 1979. Despite considerable instability in the cross-sectional configuration of the channel and the shifting of the gage height, velocity, depth, and width relations, the flow area-discharge relation has been quite consistent. This year-to-year consistency and the high degree of correlation for the flow-area relations are indicative of the river's complex adjustments in maintaining a consistent relation of channel size to discharge.

Values of daily mean discharge for the Tanana River at Fairbanks are presented in tables 2-4 for water years 1977-79 respectively. Because a continuous record of the stage is not obtained for the site near North Pole, daily mean discharges are not determined for that station. However, except for a travel-

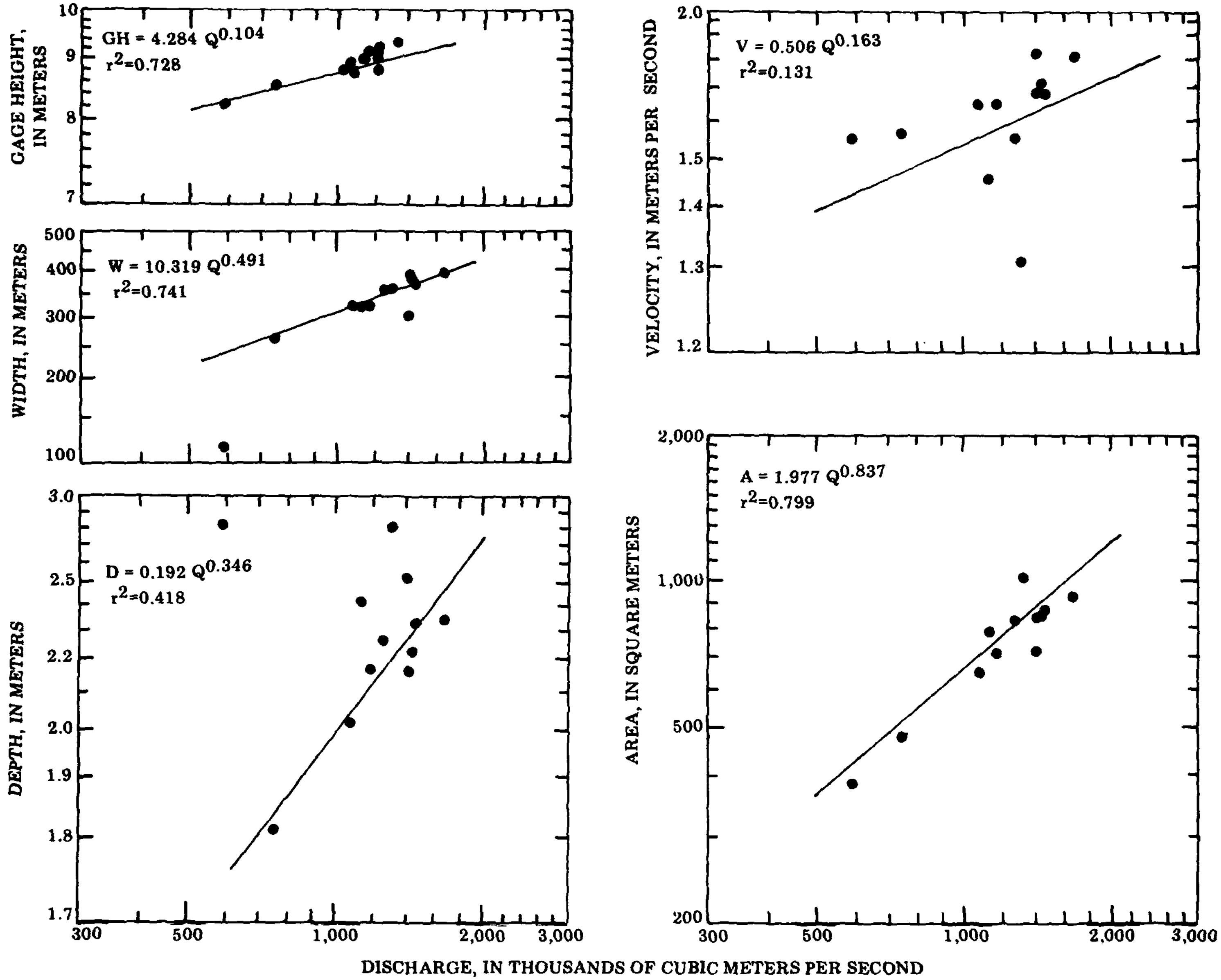

Figure 6.--At-a-station relations of hydraulic and channel geometry, Tanana River at Fairbanks, 1977.

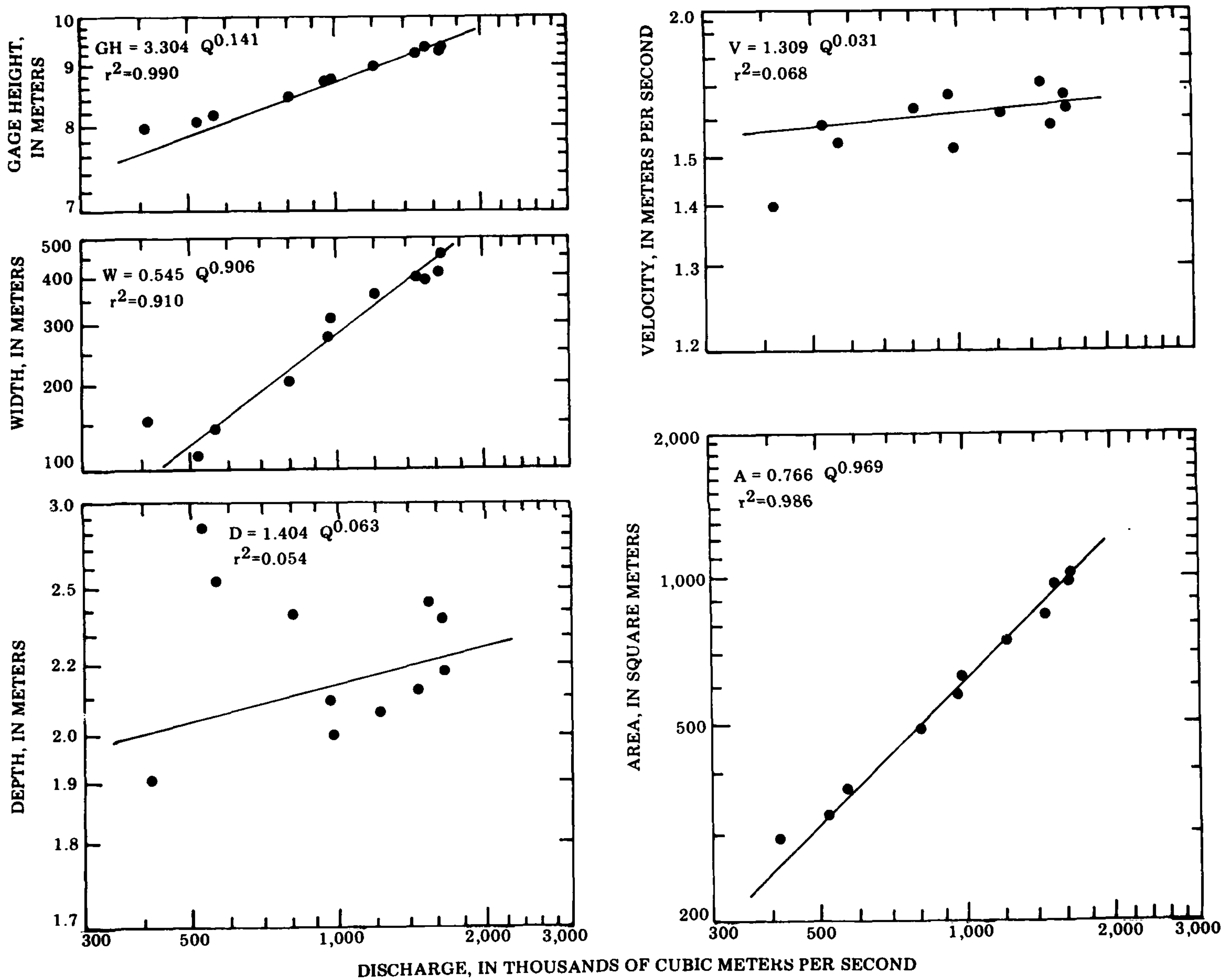

Figure 7.--At-a-station relations of hydraulic and channel geometry, Tanana River at Fairbanks, 1978.

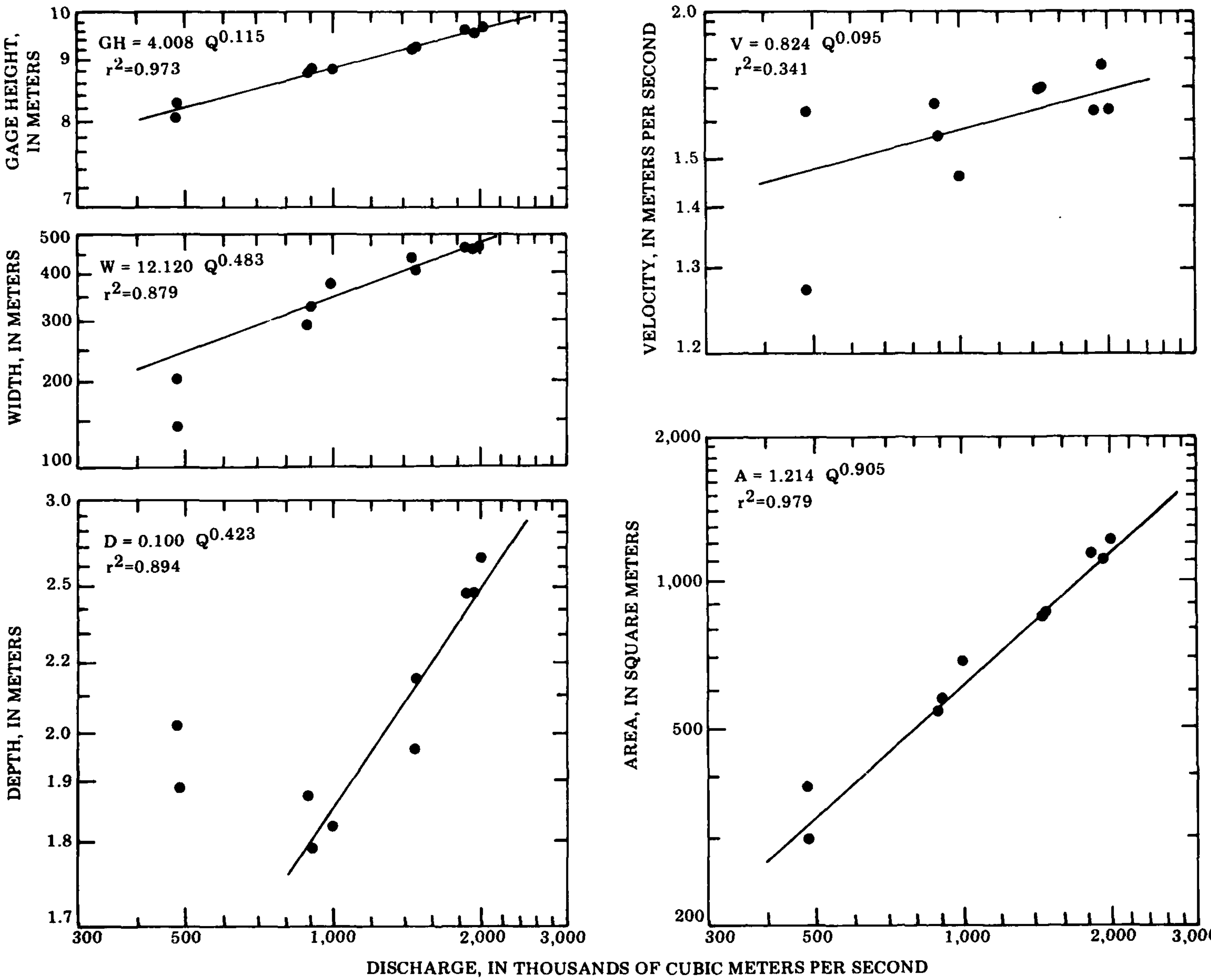

Figure 8.--At-a-station relations of hydraulic and channel geometry, Tanana River at Fairbanks, 1979.

Table 2.--Values of daily mean discharge (m^3/s), 1977 water year[1/], Tanana River at Fairbanks

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	368	170	127	127	147	176	153	396	867	1460	1550	1160
2	357	170	127	127	147	176	153	425	867	1360	1680	1100
3	346	170	127	127	147	176	159	453	821	1360	1690	1000
4	340	170	127	127	153	170	159	538	773	1350	1640	937
5	340	142	127	127	153	170	159	668	765	1210	1690	878
6	334	142	127	127	159	170	164	736	793	1100	1760	875
7	334	142	127	127	164	164	170	793	773	1060	1710	813
8	331	142	127	127	164	164	176	821	702	1030	1590	810
9	312	142	127	127	164	164	181	821	674	1030	1490	782
10	312	142	127	127	164	164	181	801	660	1100	1490	719
11	297	142	127	127	164	164	187	688	680	1150	1510	674
12	283	142	127	127	170	164	193	479	727	1150	1470	708
13	283	142	127	127	170	164	198	470	881	1220	1470	762
14	283	142	127	127	170	159	198	476	1100	1280	1470	765
15	255	142	127	127	170	159	198	473	1100	1330	1530	742
16	255	142	127	127	170	159	198	490	1130	1370	1470	736
17	255	142	127	127	170	159	227	484	1160	1370	1470	725
18	255	142	127	127	170	159	227	476	1180	1360	1460	714
19	227	142	127	127	176	153	227	521	1230	1350	1500	691
20	227	142	127	127	176	153	227	694	1230	1340	1590	680
21	227	142	127	127	176	153	255	702	1150	1300	1610	708
22	227	142	127	127	176	153	255	555	1170	1290	1530	708
23	227	127	127	127	176	153	255	490	1310	1330	1560	708
24	198	127	127	127	176	153	283	467	1390	1370	1590	680
25	198	127	127	127	176	153	283	445	1420	1390	1530	651
26	198	127	127	127	176	153	283	442	1420	1370	1470	657
27	198	127	127	127	176	153	283	470	1440	1350	1390	660
28	198	127	127	127	176	153	312	532	1430	1390	1300	666
29	170	127	127	136	---	153	340	572	1410	1420	1250	668
30	170	127	127	136	---	153	368	651	1530	1410	1150	702
31	170	---	127	142	---	153	---	736	---	1430	1150	---

1/ Winter flow period, November through April, estimated based on periodic discharge measurements, climatological records, and correlation with data obtained for Tanana Rive at Nenana.

Table 3.--Values of daily mean discharge (m^3/s), 1978 water year[1/], Tanana River at Fairbanks

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	646	210	170	164	159	156	156	538	544	790	1540	969
2	606	210	170	164	159	156	159	496	558	776	1540	923
3	578	210	170	164	159	156	159	481	606	776	1600	923
4	561	210	170	164	159	156	161	496	612	779	1570	923
5	549	210	170	164	159	156	164	510	609	807	1580	943
6	530	198	170	164	159	156	164	538	626	875	1650	954
7	510	198	170	164	159	156	167	566	623	954	1650	957
8	496	198	170	164	159	156	170	595	626	977	1610	906
9	484	198	170	164	159	156	173	623	640	974	1550	875
10	470	198	170	164	159	156	176	609	646	991	1640	867
11	450	187	170	164	159	156	178	612	668	1060	1610	844
12	433	187	170	164	159	156	181	600	702	1140	1610	844
13	416	187	170	164	159	156	187	595	762	1200	1590	[illegible]
14	413	187	170	164	159	156	193	589	784	1270	1570	799
15	405	187	170	164	159	156	198	581	838	1540	1530	759
16	368	187	170	164	159	156	204	572	847	1670	1480	702
17	283	187	170	164	159	156	210	564	850	1640	1440	663
18	198	176	170	164	159	156	215	544	830	1520	1420	649
19	181	176	170	164	159	156	227	518	767	1420	1380	617
20	181	176	170	164	159	156	238	496	742	1390	1350	595
21	187	176	170	164	159	156	244	479	728	1390	1370	572
22	193	176	170	164	159	156	255	476	697	1330	1350	558
23	204	176	170	164	159	156	266	450	677	1300	1340	527
24	210	176	170	164	159	156	278	433	725	1360	1300	515
25	221	176	170	164	159	156	297	439	765	1330	1210	498
26	227	170	170	164	159	156	312	453	759	1300	1160	484
27	229	170	170	164	159	156	368	470	759	1390	1090	481
28	227	170	170	164	159	156	425	473	770	1470	1060	481
29	221	170	170	164	---	156	566	481	782	1530	1040	476
30	215	170	170	164	---	156	581	498	801	1500	1020	462
31	210	---	170	164	---	156	---	527	---	1480	1000	---

1/ Winter flow period, November through April, estimated based on periodic discharge measurements, climatological records, and correlation with data obtained for Tanana River at Nenana.

Table 4.--Values of daily mean discharge (m^3/s), 1979 water year[1/],

Tanana River at Fairbanks

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	453	187	142	130	125	130	130	1640	821	1090	2020	1250
2	450	187	142	130	125	130	130	1470	821	1090	2060	1200
3	425	181	142	130	125	130	130	1330	821	1110	2100	1140
4	411	176	142	130	125	130	130	1440	855	1120	2120	1090
5	396	170	142	130	125	130	130	1560	867	1200	2090	1020
6	396	170	142	130	125	130	136	1440	895	1310	2040	988
7	374	170	142	130	125	130	136	1270	923	1350	2010	966
8	354	164	142	130	125	130	136	1150	952	1380	2010	960
9	346	164	142	130	125	130	136	1040	994	1420	1950	946
10	334	164	142	130	125	130	136	923	1040	1400	1880	929
11	314	159	142	130	125	130	142	833	1080	1420	1840	906
12	297	159	142	130	125	130	142	776	1110	1460	1830	889
13	283	159	142	125	125	130	147	731	1180	1480	1800	869
14	278	159	142	125	125	130	147	697	1270	1500	1800	850
15	278	159	142	125	125	130	153	651	1300	1530	1780	833
16	266	153	136	125	125	130	159	583	1180	1650	1780	818
17	261	153	136	125	125	130	159	564	1060	1770	1770	807
18	255	153	136	125	125	130	164	555	937	1810	1750	796
19	249	153	136	125	125	130	176	527	929	1770	1680	787
20	249	153	136	125	125	130	187	515	929	1800	1630	773
21	244	147	136	125	125	130	198	507	960	1800	1640	762
22	238	147	136	125	125	130	215	498	991	1800	1600	750
23	238	147	136	125	125	130	238	490	1060	1860	1490	745
24	232	147	136	125	125	130	255	498	1090	1900	1440	708
25	232	147	136	125	125	130	283	515	1120	1910	1430	691
26	227	147	136	125	125	130	312	535	1120	1930	1450	640
27	221	147	136	125	125	130	368	572	1120	1990	1470	606
28	210	147	136	125	125	130	510	617	1090	1950	1470	572
29	204	147	136	125	---	130	680	651	1090	2020	1460	547
30	198	147	136	125	---	130	1050	697	1090	2020	1400	527
31	193	---	136	125	---	130	---	753	---	2010	1320	---

[1/] Winter flow period, November through April, estimated based on periodic discharge measurements, climatological records, and correlation with data obtained for Tanana River at Nenana.

time difference of less than a day, values of daily mean discharge are approximately applicable for either site.

Bed-Material Data

Particle-size distributions for bed-material samples at Fairbanks and near North Pole are given in tables 5-7.

Graphic representation of percentages by weight of four size classes (silt, sand, gravel, and cobble) of each sample across the channel is given in figures 9-11. Cross sections shown in the bottom part of these figures are those measured August 29, 1979, at Fairbanks and August 30, 1979, for the two channels near North Pole. These sections were chosen to represent as well as possible the greatest part of the channel sampled. (No data exist for the geometry of exposed bars as bed elevations are determined from measured water depths.)

A marked difference in dominant particle size exists between the right and left parts of the channel at Fairbanks (fig. 9). From station 15 m to station 200 m the bed material is mostly silt and sand; from station 200 m to 390 m the bed material is predominantly gravel with some sand. At the North Pole site (figs. 10 and 11) the bed material in both channels is predominantly gravel with some sand and lesser amounts of silt and cobbles. The smaller particles are generally dominant on the bars, the larger particles dominant in the active channel.

Table 5.--Particle-size distribution of bed material, Tanana River at Fairbanks, September 12, 1979

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	Stationing, from right bank reference, in meters												
	15	30	45	60	75	90	105	120	135	150	165	180	195
128	---	---	---	---	---	---	---	---	---	---	---	---	---
64	---	---	---	100	---	---	---	---	---	---	---	---	---
32	---	---	---	97.2	---	100	---	---	---	---	---	---	---
16	---	---	---	84.2	100	97.3	---	---	---	---	---	---	---
8	---	---	---	52.7	94.6	92.6	---	---	---	---	---	---	---
4	---	---	---	35.6	92.3	91.6	---	---	---	---	---	---	---
2	---	100	---	27.9	91.4	91.1	---	---	---	---	---	---	---
1.0	100	99.9	100	25.9	91.1	90.9	100	100	100	100	100	100	100
0.5	99.8	99.9	99.9	24.7	91.0	90.7	99.9	99.9	99.9	99.9	99.9	99.9	99.9
0.25	99.6	99.8	95.1	16.1	85.9	83.7	86.4	89.6	99.0	88.3	94.5	66.7	65.3
0.125	98.3	96.4	69.7	7.0	45.2	42.8	19.0	53.0	81.6	30.1	41.4	5.1	2.1
0.062	88.5	72.7	44.0	4.3	17.4	14.3	5.1	35.8	39.1	10.2	12.5	0.3	0.1

Particle size (mm)	Stationing, from right bank reference, in meters												
	210	225	240	255	270	285	300	315	330	345	360	375	390
128	---	---	---	---	---	---	---	---	---	---	---	---	---
64	---	100	100	100	100	100	---	---	---	100	---	---	100
32	100	26.1	77.9	95.2	97.2	98.6	100	100	100	88.5	---	---	90.6
16	87	6.3	34.1	52.6	74.8	71.2	94.8	85.3	87.3	65	---	---	60.3
8	47.7	2.0	13.1	15.8	36.1	27.1	53.9	49	68.4	40.2	---	---	10.5
4	24.4	0.8	5.7	6.3	19.5	9.7	22.1	22.4	59.7	26.9	100	100	5.3
2	17.7	0.4	3.3	4.4	14.9	5.6	16.9	16.5	59.4	20.5	99.9	99.9	4.2
1.0	14.9	0.3	2.9	3.9	14.2	4.5	16.1	15.2	59.3	18.5	99.9	99.9	3.8
0.5	10.8	0.3	2.7	3.6	11.5	3.5	14.9	14.3	58.8	16.8	99.9	99.9	3.2
0.25	2.8	0.1	1.1	1.3	3.2	1.0	8.3	9.0	53.5	10.3	89.7	88.9	1.0
0.125	0.2	0	0.3	0.2	0.3	0.1	1.4	2.0	26.5	3.3	32.8	12.8	0
0.062	0	---	0.2	0	0	0	0.1	0.4	9.9	1.3	11.3	1.1	---

Table 6.--Particle-size distribution of bed material, north channel, Tanana River near North Pole, September 13, 1979

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	Stationing, from right bank reference, in meters													
	15	30	45	60	75	90	105	120	135	150	165	180	195	210
128	---	---	---	---	100	---	100	100	100	100	---	---	---	---
64	---	---	---	100	73.9	100	80.4	79.5	81.2	64.2	100	---	---	---
32	---	100	---	90.1	16.2	39	18.4	14.2	17.8	15.5	89.2	---	---	---
16	---	74.9	---	64.7	4.6	18	4.1	4.1	5.3	8.2	51.2	---	---	---
8	---	55.2	---	44.6	1.8	5	1.4	2.7	3.3	6.6	22.0	---	---	---
4	---	46.4	100	30.9	0.9	1.2	0.4	1.5	2.6	5.8	17.4	---	---	---
2	---	44.5	99.8	22.9	0.6	0.4	0.2	1.1	2.4	5.6	16.5	---	---	---
1	---	43.9	99.6	19.8	0.5	0.3	0.2	1.0	2.3	5.5	16.3	---	100	---
0.5	100	41.9	94.2	15.8	0.4	0.3	0.2	1.0	2.2	5.3	15.7	100	99.7	100
0.25	98	33.8	44.9	6.4	0.2	0.1	0.1	0.5	0.9	2.1	8.6	95.1	96.0	96.5
0.125	72.8	30.3	6.6	1.7	0.1	0	0	0.2	0	0	2.0	49.2	56.4	57.7
0.062	35	25.9	0.5	0.7	0	---	---	0	---	---	0.4	17.6	23.3	24.6

Particle size (mm)	Stationing, from right bank reference, in meters														
	225	240	255	270	285	300	315	330	345	360	375	390	405	420	435
128	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
64	100	100	100	100	100	100	100	100	100	100	100	100	---	100	100
32	77.2	86.2	97.3	90.7	95.9	35.6	59.0	64.9	64.0	80.1	94.4	66.8	---	90	91.8
16	44.3	53.6	64.6	71.3	69.5	21.1	29.0	22.9	24.0	57.7	70.6	35.0	---	77.1	72.8
8	22.1	22.7	30.2	53.4	57.7	12.7	12.9	9.0	5.4	29.9	34.5	9.6	---	49.6	52.4
4	11.6	20.3	25.8	50.6	57.2	6.0	7.4	3.6	2.7	19.9	15.1	2.8	---	33.2	41.2
2	10.0	20.3	25.4	50.5	57.2	4.3	6.2	2.8	2.2	19.1	14.6	1.1	---	27.5	38.3
1	9.7	20.3	25.3	50.4	57.2	4.0	5.8	2.6	2.0	18.9	14.5	1.0	100	25	37.7
0.5	9.2	20.0	24.9	50.0	57.1	3.8	5.4	2.5	1.8	18.2	12.7	0.9	99.9	22.3	35.8
0.25	5.9	15.4	19.2	47.4	56.0	2.5	2.3	1.6	0.9	11.2	6.9	0.6	55.7	8.9	15.9
0.125	1.7	6.3	8.2	37.2	41.1	0.4	0	0.3	0	5.5	2.6	0.1	2.9	3.3	3.9
0.062	0.6	3.1	4.1	20.9	20.2	0.1	---	0.2	---	3.1	1.1	0	0.3	1.8	1.6

Table 7.--Particle-size distribution of bed material, south channel, Tanana River near North Pole, September 13, 1979

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	Stationing, from right bank reference, in meters 15	30	45	60	75	90	105	120	135	150
128	---	---	---	---	---	100	100	100	100	---
64	100	100	100	100	100	75.4	64.7	61.0	75.6	100
32	98.1	45.6	51.5	60	86.7	28.9	10.2	24.3	15.2	37.2
16	81.8	11.2	29.4	23.5	67	6.1	2.6	16.3	3.3	5.8
8	55	6.8	18.5	8.8	21	3.1	1.6	10.6	1.3	1.7
4	34.3	6.1	1.6	4.4	4.9	1.8	1.1	6.9	0.9	0.7
2	24.2	5.8	9.2	3.0	4.8	1.2	0.9	5.1	0.8	0.5
1	21.8	5.6	8.5	2.7	4.8	1.0	0.9	4.6	0.7	0.5
0.5	19.2	5.2	7.9	2.6	4.7	0.8	0.8	4.2	0.6	0.4
0.25	9.2	3.5	4.5	1.7	3.0	0.4	0.2	1.4	0.4	0.2
0.125	2.2	0.7	0.4	0.2	0.3	0	0	0	0.1	0
0.062	0.6	0.2	0	0	0	---	---	---	0	---

Composite size distributions of bed material and the associated statistics are shown in table 8. The composites were derived by averaging the percentage, by weight, retained on each size sieve for all samples. Three distributions are given for each site. At Fairbanks, 90 percent of the total flow occurs between stations 180 m and 410 m, and most of the bedload transport occurs in this part of the channel. Composite particle-size distributions of bed material samples for this part of the channel, for the remainder or overflow part of the channel, and for the entire channel are shown in the top of figure 12. Particle-size distributions for North Pole are, correspondingly, north channel, south channel, and the composite of the channels. These are illustrated in the bottom of figure 12. Statistics for these distributions (table 8) show that median particle sizes of the two channels near North Pole are in the gravel range. At Fairbanks, median particle size in the overflow part of the channel is in the medium sand range and, in the main channel, in the gravel range. The bimodal size distribution of the bed material is as expected from the size distribution of previously collected bedload samples (Burrows, Parks, and Emmett, 1979).

Sediment-Transport Data

Tables 9 and 10, for the sites at Fairbanks and near North Pole respectively, list values of instantaneous water discharge, suspended-sediment concentration and transport rate, and median particle size of suspended sediment. The suspended-sediment transport rate G_S, in metric tons per day, is computed as:

$$G_S = 0.0864 \times \text{concentration (mg/L)} \times \text{water discharge (m}^3\text{/s)}.$$

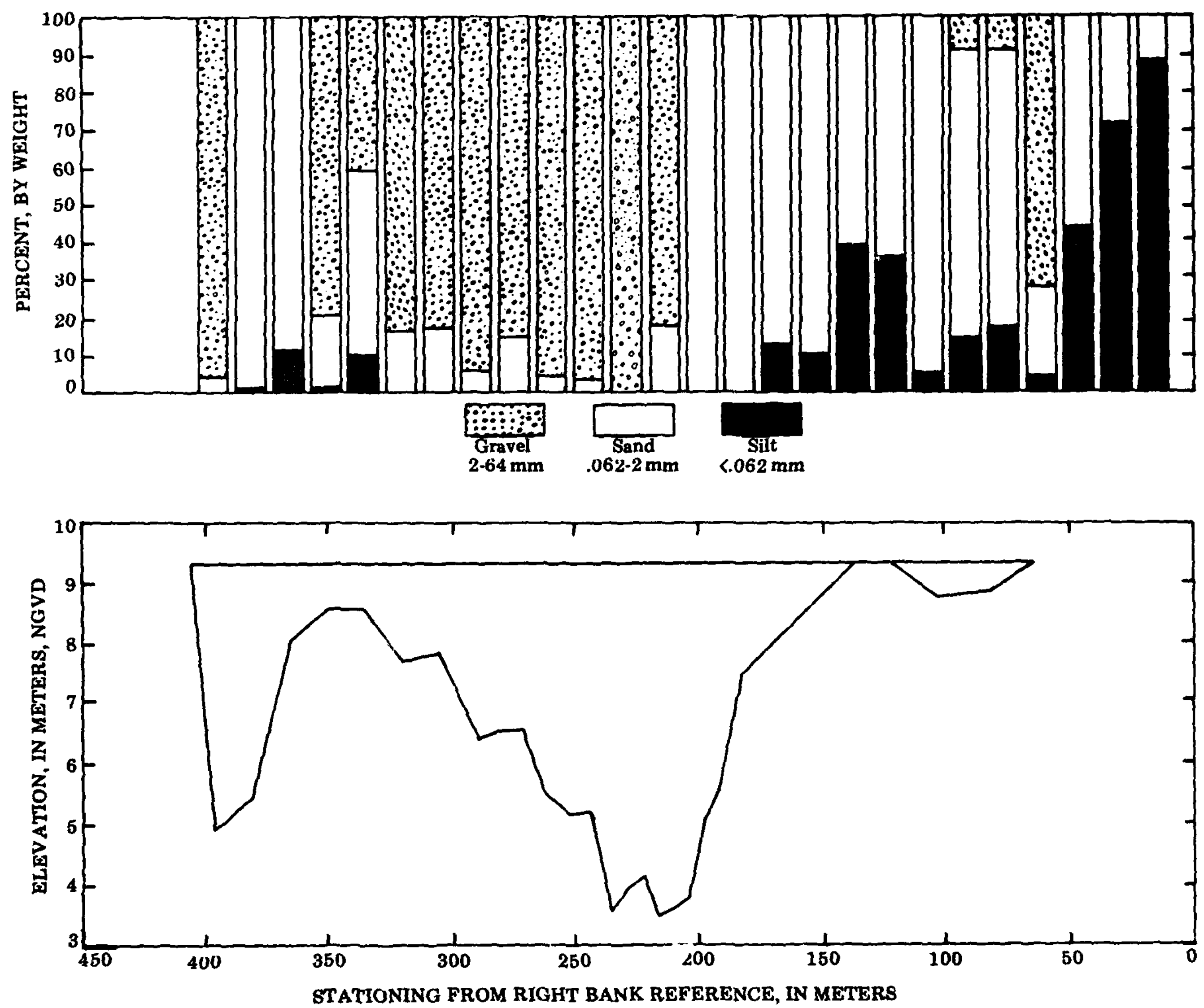

Figure 9. -- Cross-channel particle-size distribution of bed material, Tanana River, at Fairbanks, September 12, 1979.

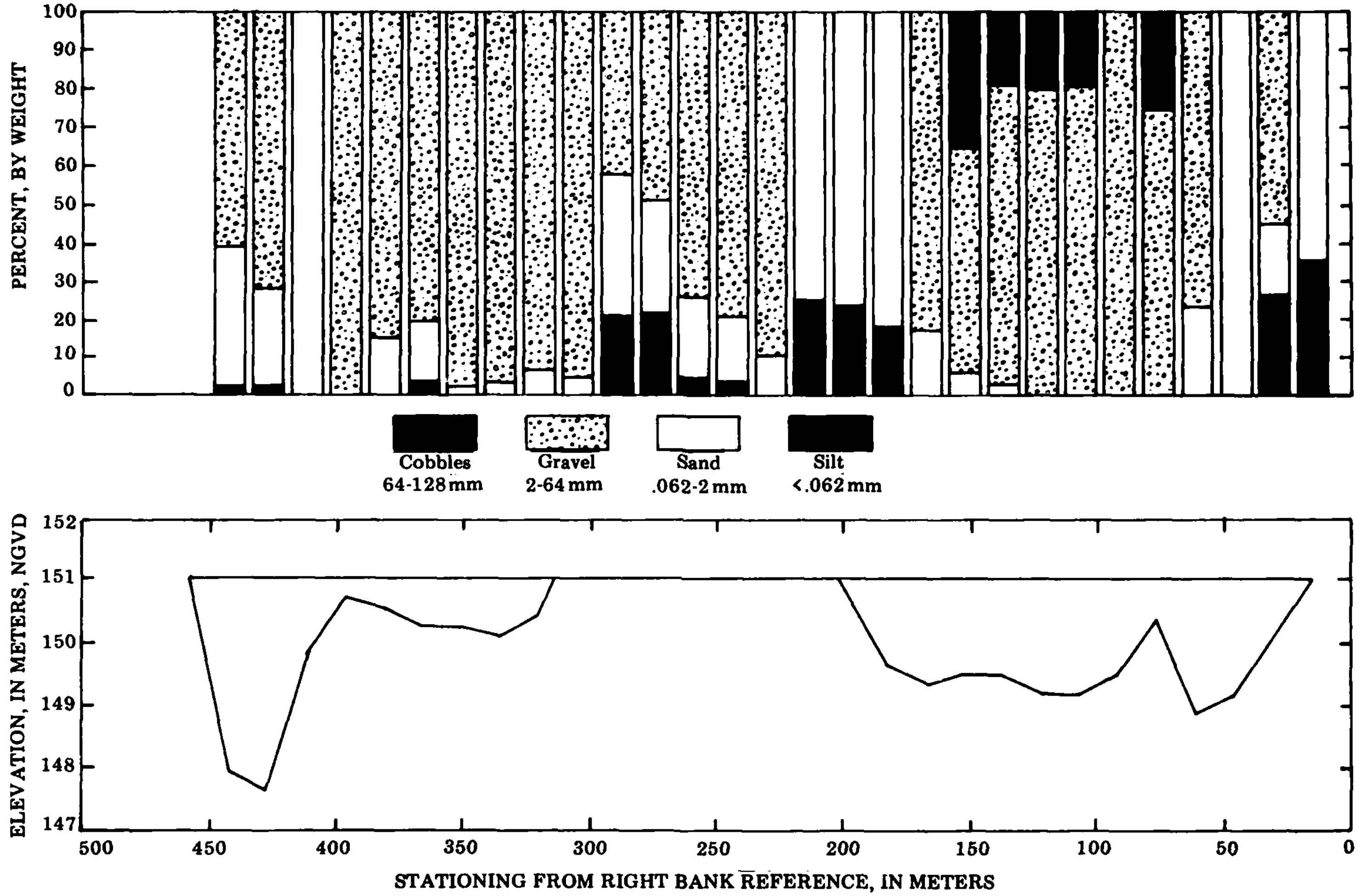

Figure 10. – Cross-channel particle-size distribution of bed material, Tanana River, north channel, near North Pole, September 13, 1979.

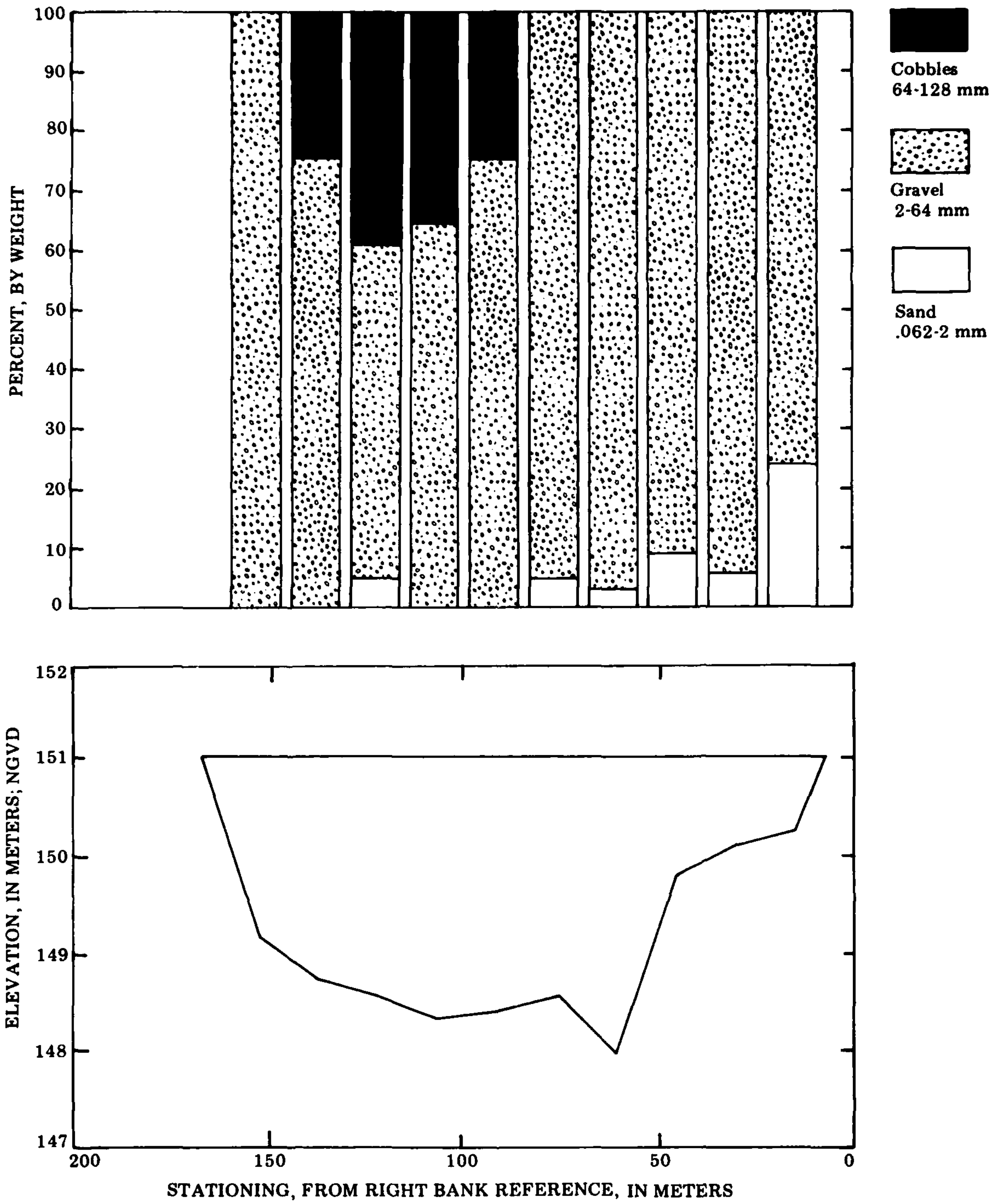

Figure 11.--Cross-channel particle-size distribution of bed material, Tanana River, south channel, near North Pole, September 13, 1979.

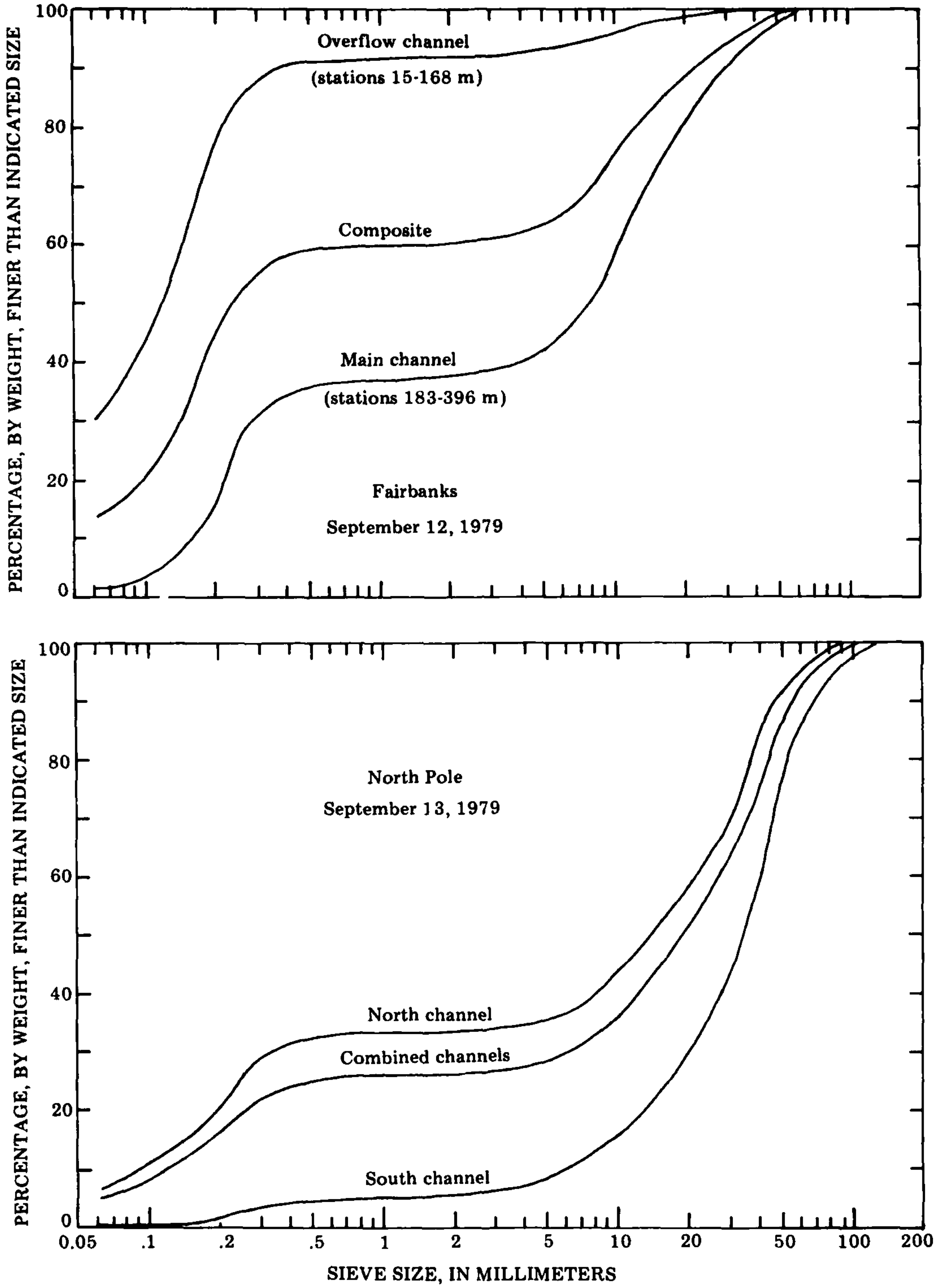

Figure 12.--Bed-material particle-size distribution, Tanana River at Fairbanks and near North Pole.

Table 8.--Composite particle-size distribution and statistics of bed material, Tanana River

[Percentage, by weight, finer than indicated sieve size]

Particle size (mm)	Fairbanks			North Pole		
	Main channel	Overflow channel	Composite of channel	North channel	South channel	Combined channels
128	---	---	---	100	100	100
64	100	100	100	95.8	87.7	93.7
32	91.6	99.7	95	72.3	45.8	65.4
16	74.6	98.3	84.6	53.4	24.7	46.0
8	50.9	94.5	69.4	39.5	12.8	32.6
4	40.2	92.6	62.4	34.7	7.2	27.6
2	37.6	91.8	60.5	33.6	5.5	26.4
1.0	36.9	91.6	60.0	33.3	5.1	26.0
.5	36.0	91.4	59.4	32.5	4.6	25.3
.25	26.8	85.3	51.5	25.3	2.4	19.4
.125	5.8	53.2	25.8	13.5	0.3	10.1
.062	1.6	31.3	14.1	6.5	0	4.8

Percent-finer parameter	Particle size statistics [Particle diameter (mm) at given percent-finer parameter]					
d_{5}	0.11	---	---	---	1.0	0.062
d_{16}	.20	---	0.072	0.15	10	.20
d_{35}	.42	0.072	.16	4.5	24	9.4
d_{50}	7.6	.12	.23	14	34	19
d_{65}	12	.16	5.8	26	46	31
d_{84}	22	.24	15	40	58	47
d_{90}	30	.35	22	47	70	55
d_{95}	40	7.4	32	60	85	68

Table 9.--Summary of suspended-sediment data, Tanana River at Fairbanks (Mg = metric tons or megagrams)

Date	Discharge (m^3/s)	Suspended sediment: Concentration (mg/L)	Suspended sediment: Transport rate (Mg/d)	Median particle size (mm)
4-13-77	197	58	987	---
4-26-77	289	146	3,650	0.19
6-07-77	750	952	61,700	.07
6-16-77	1,140	1,640	161,500	.033
6-29-77	1,320	1,860	212,000	.062
7-06-77	1,170	1,510	153,000	.077
7-12-77	1,080	1,490	139,000	.053
7-20-77	1,270	2,210	242,000	.059
7-26-77	1,420	1,820	223,000	.033
8-03-77	1,680	4,340	630,000	.023
8-11-77	1,460	3,270	412,000	.040
8-18-77	1,450	2,620	328,000	.029
8-31-77	1,410	2,020	246,000	.092
10-03-77	592	563	28,800	.16
5-18-78	566	769	37,600	.13
5-30-78	521	476	21,400	.11
6-20-78	804	975	67,700	.062
7-10-78	983	1,790	152,000	.016
7-17-78	1,650	3,700	527,000	.024
7-31-78	1,460	2,700	341,000	.029
8-08-78	1,540	2,870	382,000	.018
8-14-78	1,640	2,680	380,000	.025
8-25-78	1,220	1,250	132,000	.048
9-07-78	966	1,020	85,100	.033
10-04-78	411	389	14,000	.18
5-23-79	484	197	8,230	---
6-18-79	1,000	863	74,600	.070
7-10-79	1,490	2,100	270,000	.016
7-24-79	1,950	3,180	536,000	.031
8-01-79	2,020	3,090	539,000	.026
8-08-79	1,880	2,130	346,000	.027
8-29-79	1,460	1,650	208,000	.014
9-06-79	912	788	62,100	.066
9-12-79	895	634	49,000	.096
10-02-79	487	578	24,300	.15

Table 10.--Summary of suspended-sediment data, Tanana River near North Pole
(Mg = metric tons or megagrams)

	Discharge (m^3/s)	Suspended sediment: Concentration (mg/L)	Suspended sediment: Transport rate (Mg/d)	Median particle size (mm)
8-04-77	1,670	3,100	447,000	0.023
8-19-77	1,670	1,730	250,000	.045
5-31-78	527	594	27,000	.080
6-21-78	722	860	53,600	.060
7-11-78	1,070	2,820	261,000	.020
7-18-78	1,530	2,980	394,000	.029
8-01-78	1,550	2,640	354,000	.018
8-09-78	1,560	2,850	384,000	.023
8-15-78	1,520	2,110	277,000	.019
9-08-78	909	685	53,800	.02
10-05-78	408	160	5,640	.16
6-19-79	929	817	65,600	.076
7-13-79	1,490	2,060	265,000	.018
7-23-79	1,960	3,450	584,000	.024
7-31-79	2,010	2,690	467,000	.019
8-09-79	1,930	2,380	397,000	.032
8-30-79	1,410	1,550	189,000	.015
9-07-79	969	596	49,900	.070
9-13-79	869	556	41,800	.13
10-03-79	496	319	13,700	.14

Tables 11-13, for the sites at Fairbanks, the separate channels near North Pole, and the combined channels near North Pole, respectively, list values of river hydraulics and bedload-transport rate. The total bedload-transport rate, in metric tons per day, was computed by applying the measured unit transport rate over the width of the channel. Widths shown are those measured in the field. Previous reports used an effective-width concept to compute total bedload-transport rate. Rates thus computed may differ from those shown here, but the basic data remain the same. Slope data are computed values from the previously described relations of slope to water discharge.

The relations of sediment-transport rate to discharge are illustrated in figures 13-16. The data are from tables 9, 10, 11, and 13. The log-transformed least-squares linear regressions describing the relations are given below.

SUSPENDED SEDIMENT
(metric tons/day)

	FAIRBANKS	NORTH POLE
1977	$G_S = 3.628 \times 10^{-4}\ Q^{2.831}$ ($r^2 = 0.991$)	---
1978	$G_S = 4.757 \times 10^{-3}\ Q^{2.469}$ ($r^2 = 0.970$)	$G_S = 3.187 \times 10^{-4}\ Q^{2.848}$ ($r^2 = 0.938$)
1979	$G_S = 1.673 \times 10^{-3}\ Q^{2.564}$ ($r^2 = 0.958$)	$G_S = 5.432 \times 10^{-4}\ Q^{2.713}$ ($r^2 = 0.978$)
1977-79	$G_S = 1.235 \times 10^{-3}\ Q^{2.643}$ ($r^2 = 0.963$)	$G_S = 1.013 \times 10^{-3}\ Q^{2.650}$ ($r^2 = 0.929$)

BEDLOAD
(metric tons/day)

	FAIRBANKS	NORTH POLE
1977	$G_B = 1.268 \times 10^{-2}\ Q^{1.710}$ ($r^2 = 0.556$)	---
1978	$G_B = 2.155 \times 10^{-3}\ Q^{1.952}$ ($r^2 = 0.862$)	$G_B = 2.875 \times 10^{-3}\ Q^{1.921}$ ($r^2 = 0.848$)
1979	$G_B = 2.308\ Q^{0.977}$ ($r^2 = 0.819$)	$G_B = 7.025 \times 10^{-3}\ Q^{1.774}$ ($r^2 = 0.835$)
1977-79	$G_B = 4.537 \times 10^{-2}\ Q^{1.524}$ ($r^2 = 0.715$)	$G_B = 6.604 \times 10^{-3}\ Q^{1.789}$ ($r^2 = 0.840$)

Only two measurements of sediment transport were made near North Pole in 1977, both at a fairly high water discharge. These data are plotted on figure 13, but the data are too few to define a meaningful relation. Differences in

Table 11.--Summary of bedload data, Tanana River at Fairbanks
(Mg = metric tons or megagrams)

Date	Discharge (m^3/s)	Slope (m/m)	Width (m)	Bedload-transport rate: Unit [(kg/m)/s]	Bedload-transport rate: Total (Mg/d)	Median particle size (mm)
6-07-77	750	0.00047	264	0.03869	883	9.0
6-29-77	1,320	.00050	360	.24820	7,720	10
7-06-77	1,170	.00050	326	.06562	1,850	20
7-12-77	1,080	.00049	323	.09330	2,600	1.8
7-20-77	1,270	.00050	360	.04524	1,410	16
8-03-77	1,680	.00052	396	.15951	5,460	15
8-11-77	1,460	.00041	372	.12410	3,990	20
8-18-77	1,450	.00051	378	.06934	2,260	0.44
8-31-77	1,410	.00051	305	.06309	1,660	.30
10-03-77	592	.00046	134	.06770	784	.30
5-18-78	566	.00046	145	.02902	364	.21
5-30-78	521	.00045	116	.03482	349	.21
6-20-78	804	.00048	207	.08348	1,490	.25
7-10-78	983	.00049	317	.02738	750	.19
7-17-78	1,650	.00052	463	.16100	6,440	.28
7-31-78	1,460	.00051	402	.07113	2,470	.26
8-08-78	1,540	.00051	399	.07529	2,600	.26
8-14-78	1,640	.00052	415	.15073	5,400	.40
8-25-78	1,220	.00050	366	.07276	2,300	.29
9-07-78	966	.00049	277	.07782	1,860	.29
10-04-78	411	.00044	154	.03125	416	.32
5-23-79	484	.00045	201	.03880	674	.26
6-18-79	1,000	.00049	375	.08946	2,900	.27
7-10-79	1,490	.00051	408	.08586	3,030	.33
7-24-79	1,950	.00053	454	.08550	3,350	4.8
8-01-79	2,020	.00051	469	.08719	3,530	.4
8-08-79	1,880	.00053	466	.10576	4,260	6.2
8-29-79	1,460	.00053	436	.07594	2,860	.33
9-06-79	912	.00048	326	.05116	1,440	.39
9-12-79	895	.00048	290	.06039	1,510	.30
10-02-79	487	.00045	143	.11404	1,410	.26

Table 12.--Summary of bedload data, north and south channels of Tanana River near North Pole
(Mg = metric tons or megagrams)

	North Channel				South Channel			
		Bedload-transport rate				Bedload-transport rate		
Date	Width (m)	Unit [(kg/m)/s]	Total (Mg/d)	Median particle size (mm)	Width (m)	Unit [(kg/m)/s]	Total (Mg/d)	Median particle size (mm)
8-04-77	244	0.14047	2,960	12	187	0.05342	863	15
8-19-77	218	.11026	2,080	11	200	.04598	795	5.4
5-31-78	99	.09181	785	0.26	174	.01146	172	2.3
6-21-78	125	.02039	220	.19	178	.01592	245	0.26
7-11-78	277	.10327	2,470	7.7	186	.04732	760	13
7-18-78	424	.04881	1,790	.26	210	.07916	1,440	9.5
8-01-78	475	.06845	2,810	11	180	.07366	1,150	20
8-09-78	460	.04985	1,980	.28	204	.12737	2,240	9.0
8-15-78	454	.07128	2,800	.29	200	.06443	1,110	12
9-08-78	219	.04077	771	.42	183	.01056	167	.26
10-05-78	165	.01190	170	.30	168	.00565	82	.24
6-19-79	280	.04784	1,160	.35	166	.02372	340	.28
7-13-79	259	.18819	4,210	11	162	.18607	2,600	12
7-23-79	381	.13162	4,330	12	162	.10083	1,410	8.4
7-31-79	244	.12928	2,730	14	158	.05901	806	.33
8-09-79	268	.14368	3,330	20	168	.03737	542	.33
8-30-79	329	.05412	1,540	.24	160	.06829	944	5.4
9-07-79	186	.05343	859	3.3	162	.01731	242	.30
9-13-79	140	.03881	469	.32	158	.02357	322	.32
10-03-79	125	.03583	387	.27	149	.00672	87	.37

Table 13.--Summary of bedload data, composite channels of Tanana River near North Pole
(Mg = metric tons or megagrams)

Date	Discharge (m^3/s)	Slope (m/m)	Width (m)	Bedload-transport rate: Unit [(kg/m)/s]	Bedload-transport rate: Total (Mg/d)	Median particle size (mm)
8-04-77	1,670	0.00109	431	0.10258	3,820	13.0
8-19-77	1,670	.00109	418	.07974	2,880	9.6
5-31-78	527	.00122	273	.04057	957	0.26
6-21-78	722	.00118	303	.01776	465	.22
7-11-78	1,070	.00114	463	.08074	3,230	8.4
7-18-78	1,530	.00110	634	.05897	3,230	.34
8-01-78	1,550	.00109	655	.06997	3,960	13
8-09-78	1,560	.00109	664	.07356	4,220	1.6
8-15-78	1,520	.00110	654	.06920	3,910	.33
9-08-78	909	.00115	402	.02701	938	.35
10-05-78	408	.00125	333	.00876	252	.27
6-19-79	929	.00113	446	.03893	1,500	.33
7-13-79	1,490	.00108	421	.18722	6,810	11
7-23-79	1,960	.00105	543	.12235	5,740	11
7-31-79	2,010	.00104	402	.10192	3,540	10
8-09-79	1,930	.00105	436	.10273	3,870	17
8-30-79	1,410	.00108	489	.05870	2,480	.58
9-07-79	969	.00112	348	.03658	1,100	.41
9-13-79	869	.00114	298	.03072	791	.32
10-03-79	496	.00120	274	.02002	474	.27

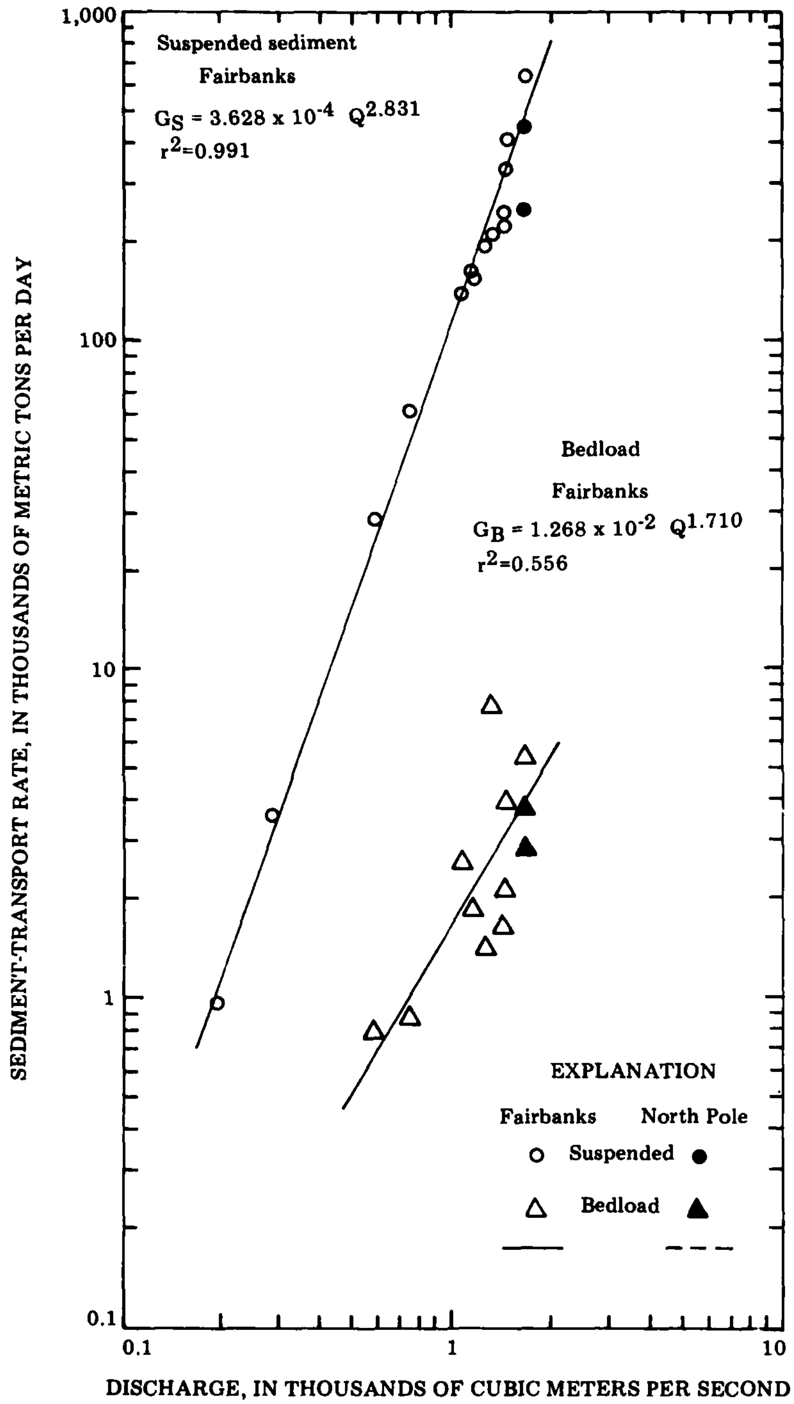

Figure 13.--Sediment-transport rate as a function of discharge, Tanana River at Fairbanks and near North Pole, 1977.

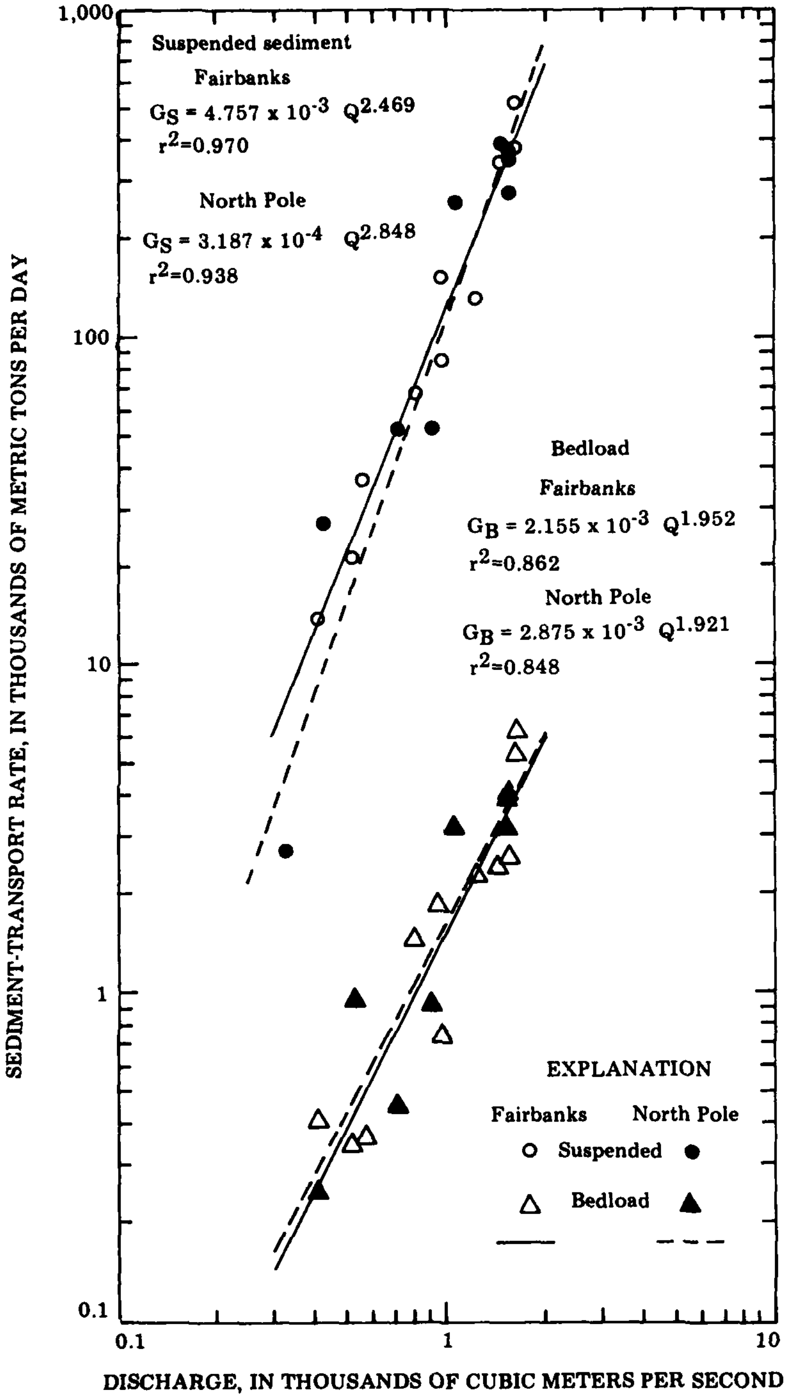

Figure 14.--Sediment-transport rate as a function of discharge, Tanana River at Fairbanks and near North Pole, 1978.

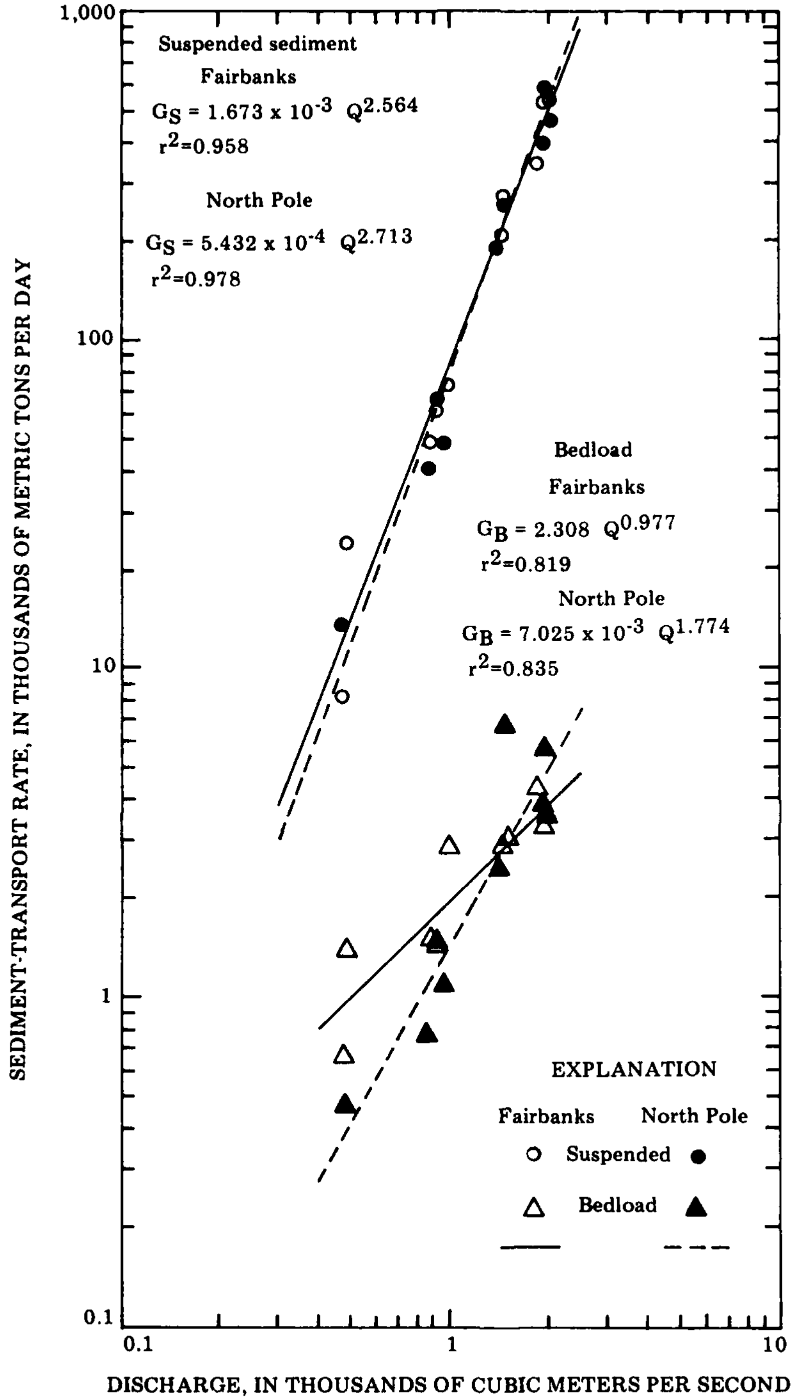

Figure 15.--Sediment-transport rate as a function of discharge, Tanana River at Fairbanks and near North Pole, 1979.

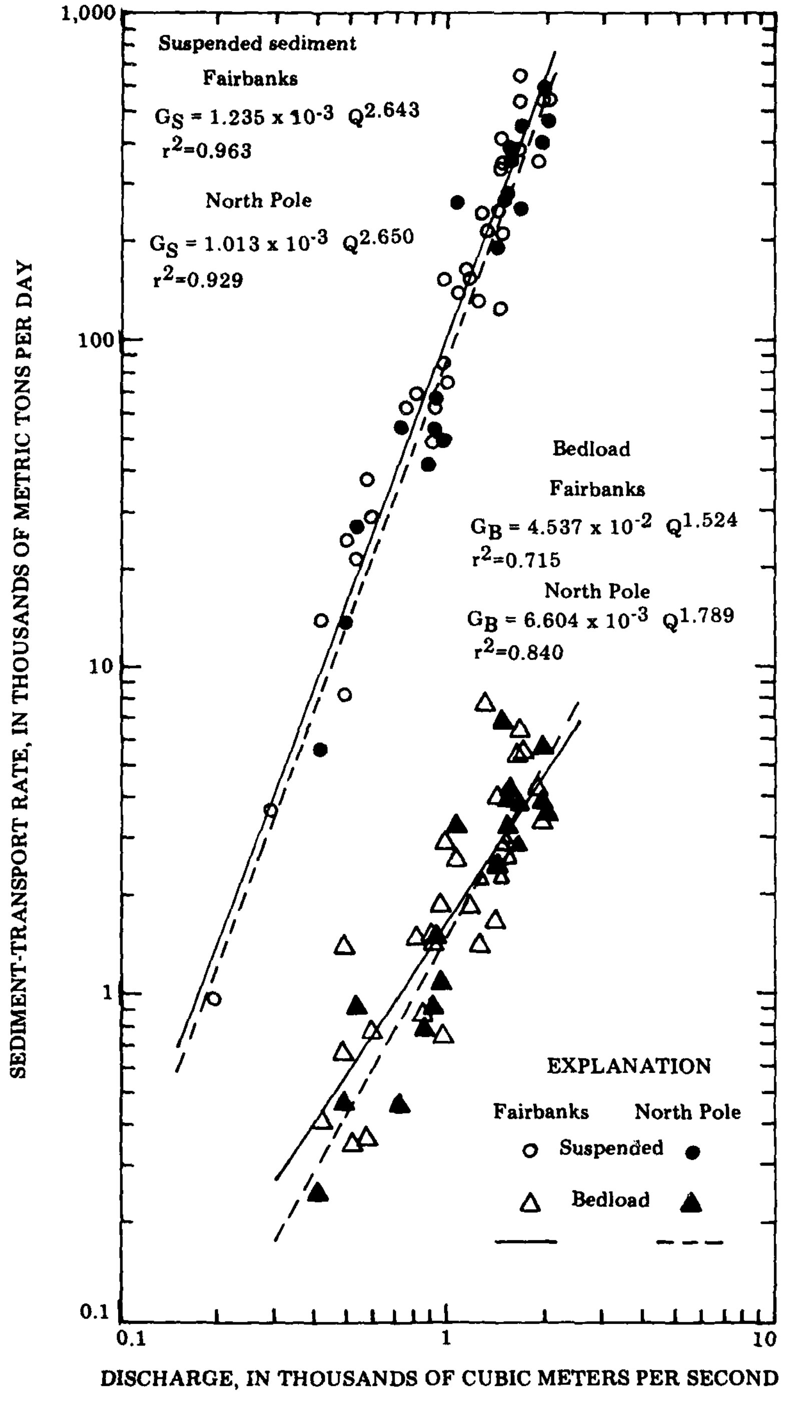

Figure 16.--Sediment-transport rate as a function of discharge, Tanana River at Fairbanks and near North Pole, 1977-79.

transport functions from year to year and between the two stations are noticeable; the effect of these differences on annual loads will be shown later. The relations derived from all the data for each site (fig. 16) show that more suspended sediment is in transport at Fairbanks than near North Pole over the whole range of discharge. Bedload-transport relations in figure 16 indicate more transport at Fairbanks than at North Pole at low discharges and less than North Pole at high discharges.

Bedload-transport rate is two orders of magnitude less than that of the suspended sediment. There is considerable consistency to the measured data; in figure 16, four-fifths of the bedload-transport data fall in the range of 0.6 to 3.0 percent of the corresponding suspended-sediment transport rate.

Particle-Size Data for Suspended-Sediment and Bedload

Tables 14 and 15, for the sites at Fairbanks and North Pole, respectively, present the size distribution data for suspended sediment. Size determination was made by sieve analysis for particles larger than silt (<0.062 mm), and by pipet analysis for particles of silt size and smaller. All data are expressed in percentage, by weight, finer than indicated particle size. Values of median particle size were determined graphically and are included as part of the suspended-sediment data in tables 9 and 10.

Regression of median particle size as a function of water discharge for all data yields:

$$d_{50}\ (\mathrm{mm}) = 2.089 \times 10^{-2}\ Q^{-1.22} \qquad (r^2 = 0.532)$$

Median particle size is, therefore, generally in the silt range (<0.062 mm, >0.004 mm), and only at discharges less than about 850 m^3/s is median particle size within the very fine sand range (>0.062 mm, <0.125 mm). The reasonably defined relation of median particle size of suspended sediment decreasing as discharge increases suggests a watershed source of sediment during snowmelt runoff and within-channel source of sediment during lower runoff periods.

Tables 16-18, for the sites at Fairbanks, the separate channels near North Pole, and the combined channels near North Pole, respectively, present particle-size distribution data for bedload as determined by dry-sieve analysis. Statistics of the particle-size determinations are presented in tables 19-21. This latter compilation of data is especially useful in visualization of bedload-particle sizes as functions of discharge or bedload-transport rate. The median particle size, d_{50}, from this compilation is included in tables 11-13 as part of the bedload data. For either location, the median particle size of bedload was sometimes in the gravel range (>2.0 mm, <64 mm), but at other times in the medium sand range. This abrupt change in median particle size has been observed previously (Emmett, 1976) and is apparently related to the availability and mobility of particles composing the bed material.

The transport-rate weighted, yearly composite size distributions are presented in table 22 and illustrated in figures 17 and 18. These size distributions are obtained by using the actual weights of samples collected at nearly

Table 14.--Particle-size distribution of suspended sediment, Tanana River at Fairbanks

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	4-26-77	6-07-77	6-16-77	6-29-77	7-06-77	7-12-77	7-20-77	7-26-77	8-03-77	8-11-77	8-18-77
1.0	---	---	---	---	100	---	---	---	---	---	---
.50	100	100	100	100	99	100	100	100	100	100	100
.25	90	95	99	96	94	97	97	97	98	98	97
.125	44	68	89	74	71	77	75	85	88	81	83
.062	28	45	69	51	43	52	52	63	71	61	62
.031	---	37	49	35	29	44	36	49	56	45	51
.016	---	29	38	30	20	33	31	34	43	36	39
.008	---	22	[illegible]	16	16	23	23	31	27	26	27
.004	---	16	15	9	14	15	14	18	21	19	20
.002	---	10	11	6	8	6	5	14	12	8	11

Particle size (mm)	8-31-77	10-03-77	5-18-78	5-30-78	6-20-78	7-10-78	7-17-78	7-31-78	8-08-78	8-14-78	8-25-78
1.0	---	---	---	---	---	---	---	---	---	---	---
.50	100	100	100	100	100	100	100	100	100	100	100
.25	95	88	92	94	97	99	99	98	99	99	99
.125	61	32	47	56	68	89	91	87	92	88	79
.062	41	20	29	37	50	76	74	64	77	71	56
.031	31	14	23	28	40	63	56	52	62	55	42
.016	25	10	17	21	33	50	42	39	48	41	31
.008	18	6	12	15	28	37	30	29	36	30	23
.004	12	4	8	10	22	25	22	22	28	24	16
.002	5	2	6	7	16	18	18	16	22	18	13

Particle size (mm)	9-07-78	10-04-78	6-18-79	7-10-79	7-24-79	8-01-79	8-08-79	8-29-79	9-06-79	9-12-79	10-02-79
1.0	---	---	---	---	96	---	---	---	---	---	---
.50	100	100	100	---	96	100	100	100	100	100	100
.25	97	89	97	100	94	99	99	98	96	95	93
.125	73	32	68	90	77	88	88	80	69	61	39
.062	57	19	48	74	64	67	67	69	49	43	23
.031	49	---	36	63	50	53	53	63	39	27	16
.016	39	---	28	50	35	42	39	52	31	20	12
.008	28	---	21	37	25	30	29	40	24	14	9
.004	20	---	14	26	18	24	21	29	17	9	7
.002	16	---	---	---	---	---	---	23	12	9	6

Table 15.--Particle-size distribution of suspended sediment, Tanana River near North Pole

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78
1.0	---	---	---	---	---	---	---	---	---	---
.50	100	100	100	100	100	100	100	100	---	100
.25	99	99	92	96	99	98	98	99	100	98
.125	90	89	62	67	88	84	91	89	90	78
.062	70	72	44	51	73	67	77	72	75	66
.031	56	39	33	44	59	51	61	56	61	56
.016	43	36	24	37	45	39	48	43	47	46
.008	29	32	16	31	32	27	32	32	35	35
.002	11	12	7	19	17	18	17	17	19	20

Particle size (mm)	10-05-78	6-19-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
1.0	---	---	---	---	---	---	---	---	---	---
.50	100	100	100	100	100	100	100	100	100	100
.25	83	97	99	98	98	98	97	92	85	86
.125	41	63	89	84	89	84	80	61	49	45
.062	31	46	72	64	72	64	69	48	36	34
.031	---	37	61	49	58	49	61	40	28	28
.016	---	29	48	37	46	37	52	29	22	22
.008	---	22	36	27	34	27	41	22	16	17
.004	---	16	26	19	26	19	31	15	11	13
.002	---	---	---	---	---	---	23	12	9	10

Table 16.--Particle-size distribution of bedload sediment, Tanana River at Fairbanks

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	6-07-77	6-29-77	7-06-77	7-12-77	7-20-77	8-03-77	8-11-77	8-18-77	8-31-77	10-03-77
128	---	---	100.0	---	100.0	---	100.0	---	---	---
64	100.0	100.0	98.0	100.0	99.0	100.0	95.8	100.0	100.0	---
32	99.0	95.4	84.0	94.0	69.8	82.5	81.5	98.0	99.0	---
16	76.5	74.0	45.0	73.5	50.0	55.0	48.0	88.0	81.0	---
8	47.0	41.5	35.0	59.5	35.0	32.0	41.4	70.5	71.0	100.0
4	36.0	26.8	31.2	51.5	28.7	26.5	35.3	62.5	67.8	99.8
2	35.4	25.6	30.0	50.3	27.7	25.3	34.5	61.4	67.2	99.6
1.0	35.1	25.4	39.5	49.0	26.5	25.2	34.0	61.0	67.0	99.5
.5	34.8	25.0	21.5	47.5	25.0	25.1	33.2	54.0	66.2	97.0
.25	15.9	12.5	5.0	21.0	10.0	8.0	15.0	30.0	33.0	33.0
.125	3.0	1.5	.4	2.0	1.5	1.0	2.5	2.0	1.5	8.0
.062	.5	.7	.1	.5	.5	.4	1.2	.9	.7	.3

Particle size (mm)	5-18-78	5-30-78	6-20-78	7-10-78	7-17-78	7-31-78	8-08-78	8-14-78	8-25-78	9-07-78	10-04-78
128	---	---	---	---	---	---	---	---	---	---	---
64	---	---	---	100.0	100.0	100.0	---	100.0	100.0	---	100.0
32	100.0	100.0	---	93.4	98.9	98.4	100.0	80.2	98.3	100.0	71.3
16	99.1	93.0	100.0	93.4	92.1	95.4	91.4	67.6	92.9	94.4	63.6
8	95.5	90.2	90.4	90.9	88.2	89.2	84.8	60.4	88.8	88.7	60.7
4	92.4	89.6	80.4	89.6	85.5	86.0	81.5	54.9	86.8	86.1	58.8
2	91.7	89.4	79.0	89.2	84.4	85.2	80.5	53.8	86.4	85.5	57.8
1.0	91.6	89.2	78.8	89.0	83.9	84.9	79.8	53.4	86.2	85.2	57.4
.5	91.4	88.9	78.4	88.5	82.4	84.1	77.4	52.7	85.1	84.3	57.0
.25	72.3	72.4	48.0	74.4	32.0	37.0	44.7	26.3	30.4	31.5	39.2
.125	8.6	8.6	7.4	18.7	7.3	3.8	7.8	4.0	3.0	2.9	1.7
.062	1.3	1.7	1.7	5.0	1.7	1.1	2.3	1.2	.5	.4	.2

Particle size (mm)	5-23-79	6-18-79	7-10-79	7-24-79	8-01-79	8-08-79	8-29-79	9-06-79	9-12-79	10-02-79
128	---	---	---	---	---	---	---	---	---	---
64	---	---	100.0	100.0	---	100.0	---	---	---	---
32	100.0	100.0	96.1	96.0	100.0	99.1	100.0	100.0	100.0	100.0
16	96.2	99.6	89.2	83.6	81.7	81.1	86.4	85.7	97.0	95.4
8	88.0	98.3	84.2	58.7	67.8	57.6	73.4	65.4	92.4	82.8
4	84.4	97.6	81.0	48.8	62.3	43.8	66.8	57.2	90.1	77.8
2	83.6	97.3	80.2	46.7	61.3	39.0	65.0	55.5	89.6	77.1
1.0	83.3	97.2	79.9	46.4	61.0	36.6	64.5	54.9	89.3	76.8
.5	82.6	96.1	78.8	45.6	60.2	34.1	63.6	53.9	88.6	76.0
.25	45.6	34.3	7.6	18.6	15.4	13.1	7.7	9.0	17.4	44.6
.125	8.8	5.7	1.4	5.2	4.0	3.3	1.6	1.1	2.1	3.1
.062	1.3	1.1	.4	1.4	1.1	.9	.4	.1	.2	.4

Table 17.--Particle-size distribution of bedload sediment, north and south channels, Tanana River near North Pole

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	North channel										
	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78	10-05-78
128	---	---	---	---	---	---	---	---	---	---	---
64	100.0	100.0	100.0	---	100.0	100.0	100.0	---	100.0	---	---
32	81.0	95.5	95.0	---	86.8	97.8	83.7	100.0	95.9	100.0	100.0
16	59.0	76.0	93.8	---	72.1	87.4	60.0	95.0	85.2	76.8	97.2
8	39.5	40.5	93.6	---	50.7	83.2	44.3	90.1	82.7	61.9	89.7
4	33.5	29.5	93.5	---	41.2	80.9	40.9	87.0	81.8	56.5	86.5
2	33.0	29.0	93.3	---	39.6	80.1	39.9	85.6	81.3	54.5	82.4
1.0	32.5	28.9	93.2	100.0	39.4	79.6	39.2	84.9	81.0	53.4	80.6
.5	32.0	28.6	92.3	99.8	39.0	78.1	37.7	83.5	79.7	52.4	79.0
.25	18.0	13.0	47.2	76.8	24.2	47.5	22.4	41.9	39.0	32.4	33.4
.125	4.0	1.5	5.3	13.4	4.2	9.7	4.6	8.8	6.0	2.1	.5
.062	1.5	.6	1.4	3.4	1.3	2.4	1.3	2.7	1.7	.3	.1

Particle size (mm)	South channel										
	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78	10-05-78
128	---	---	---	---	---	---	---	---	---	---	---
64	100.0	100.0	---	---	100.0	100.0	100.0	100.0	100.0	---	---
32	77.5	82.0	100.0	100.0	91.0	81.9	64.9	78.5	85.4	100.0	---
16	53.0	69.0	58.2	89.2	54.3	60.8	44.9	64.1	59.1	86.3	100.0
8	35.5	59.0	54.5	82.2	40.2	47.5	33.1	47.0	40.1	78.4	97.6
4	30.0	47.8	51.8	78.2	33.2	41.3	27.3	30.0	33.7	77.2	97.6
2	29.5	45.7	49.8	74.9	29.4	38.8	24.9	19.7	31.3	76.9	97.5
1.0	29.0	45.0	49.0	72.8	27.8	38.2	23.6	17.9	29.7	76.8	97.3
.5	28.5	44.0	48.0	70.8	26.6	37.0	21.8	16.6	28.4	76.1	95.9
.25	12.5	22.0	32.0	48.0	16.0	18.0	9.0	8.2	15.9	49.0	51.6
.125	.8	3.0	3.9	6.0	2.9	3.1	1.3	1.6	3.1	2.2	.6
.062	.4	1.3	1.3	1.4	.9	.9	.5	.6	1.0	.6	.1

Particle size (mm)	North channel								
	6-19-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
128	---	---	---	---	---	---	---	---	---
64	100.0	100.0	100.0	100.0	100.0	---	100.0	---	---
32	95.7	86.0	87.2	82.2	68.7	100	89.8	100.0	---
16	80.2	65.1	63.7	58.4	40.2	83.8	81.9	79.5	---
8	67.3	40.5	39.2	28.9	22.8	66.6	63.4	74.0	---
4	60.4	28.9	31.5	16.9	16.5	58.5	51.1	70.8	100.0
2	59.0	26.9	29.6	13.5	13.9	55.2	48.2	70.0	99.9
1.0	57.8	26.6	29.0	12.8	12.8	53.8	47.1	68.9	99.8
.5	56.2	26.0	28.1	12.3	11.6	51.7	45.5	67.7	98.8
.25	13.1	6.9	13.9	4.2	3.4	9.4	12.6	20.8	27.8
.125	1.0	1.3	3.5	1.0	.8	2.2	1.5	1.7	1.3
.062	.2	.3	.8	.3	.3	.4	.3	.2	.2

Particle size (mm)	South channel								
	6-19-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
128	---	---	---	---	---	---	---	---	---
64	---	100.0	100.0	---	---	100.0	---	---	---
32	---	93.0	73.6	100.0	100.0	95.0	100.0	100.0	100.0
16	100.0	64.0	62.3	93.2	79.6	69.0	82.7	99.2	86.5
8	99.0	36.2	49.3	84.0	71.0	53.8	78.3	84.5	78.4
4	95.1	21.1	39.3	80.6	65.9	47.5	73.2	72.5	73.1
2	92.3	16.3	36.7	80.1	64.3	45.8	69.2	69.5	69.5
1	91.7	15.9	35.8	79.9	63.7	45.0	67.4	68.3	66.6
.5	90.6	15.7	34.0	78.8	62.4	43.7	65.3	66.1	60.5
.25	27.2	6.7	14.6	26.7	24.2	13.0	23.4	20.8	19.9
.125	3.5	1.0	4.4	6.2	5.1	2.1	1.3	1.2	.7
.062	.8	.3	1.5	1.7	1.5	.5	.3	.2	.2

Table 18.--Particle-size distribution of bedload sediment, composite channels of Tanana River near North Pole

[Percentage, by weight, finer than particle size indicated]

Particle size (mm)	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78
128	---	---	---	---	---	---	---	---	---	---
64	100.0	100.0	100.0	---	100.0	100.0	100.0	100.0	100.0	---
32	80.0	91.5	95.9	100.0	87.8	90.7	78.2	88.6	95.9	100.0
16	57.0	74.0	87.4	94.3	67.9	75.5	55.7	78.6	77.8	78.4
8	38.5	43.5	86.6	90.6	48.2	67.3	41.1	67.2	70.5	64.8
4	32.5	34.0	86.0	88.5	39.4	63.2	37.0	56.7	68.1	60.2
2	32.2	33.6	85.5	86.8	37.2	61.6	35.6	50.6	67.1	58.5
1.0	31.5	33.3	85.2	85.7	36.6	61.1	34.7	49.3	66.4	57.5
.5	31.0	33.0	84.4	84.5	36.0	59.8	33.1	47.9	65.1	56.6
.25	16.0	16.0	44.5	61.6	22.3	34.3	18.5	24.0	32.4	35.4
.125	3.0	2.0	5.1	9.4	3.9	6.8	3.7	5.0	5.2	2.2
.062	1.2	.8	1.4	2.4	1.2	1.8	1.1	1.6	1.5	.4

Particle size (mm)	10-05-78	6-19-79	7-13-79	7-24-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
128	---	---	---	---	---	---	---	---	---	---
64	---	100.0	100.0	100.0	100.0	100.0	100.0	100.0	---	---
32	100.0	96.6	88.8	82.8	87.2	74.3	98.6	92.5	100.0	100.0
16	98.2	84.7	64.7	63.2	68.2	47.2	79.6	82.1	87.4	97.4
8	92.6	74.4	38.8	42.5	44.4	31.4	63.0	67.4	78.3	95.8
4	90.6	68.2	25.8	34.0	34.8	25.3	55.4	56.9	71.5	94.8
2	87.9	66.5	22.7	31.9	32.3	22.9	52.6	53.8	69.5	94.0
1.0	86.7	65.5	22.3	31.2	31.7	21.9	51.3	52.5	68.7	93.4
.5	85.2	63.9	21.9	30.0	31.0	20.6	49.4	50.7	67.0	91.4
.25	40.0	16.2	6.8	14.1	10.6	7.2	10.4	15.5	20.8	26.2
.125	.5	1.5	1.1	3.8	2.5	1.6	2.2	1.5	1.5	1.2
.062	.1	.3	.3	1.0	.7	.5	.4	.3	.2	.2

Table 19.--Statistical data for particle-size distribution of bedload sediment, Tanana River at Fairbanks

[Particle diameter (mm) at given percent-finer parameter]

Percent-finer parameter	6-07-77	6-29-77	7-06-77	7-12-77	7-20-77	8-03-77	8-11-77	8-18-77	8-31-77	10-03-77
d_5	0.17	0.19	0.25	0.16	0.18	0.21	0.16	0.14	0.15	0.12
d_{16}	.26	.29	.32	.23	.33	.31	.27	.19	.21	.15
d_{35}	.80	7.0	8.0	.32	8.0	9.4	2.5	.27	.27	.26
d_{50}	9.0	10	20	1.8	16	15	20	.44	.30	.30
d_{65}	12	13	28	11	24	20	24	5.8	.40	.32
d_{84}	20	20	32	22	45	34	33	14	17	.37
d_{90}	22	24	36	28	48	39	44	17	22	.40
d_{95}	24	31	58	37	56	45	59	23	27	.43

Percent-finer parameter	5-18-78	5-30-78	6-20-78	7-10-78	7-17-78	7-31-78	8-08-78	8-14-78	8-25-78	9-07-78	10-04-78
d_5	0.10	0.10	0.11	0.06	0.10	0.13	0.09	0.14	0.14	0.14	0.14
d_{16}	.15	.15	.16	.12	.19	.19	.16	.20	.19	.19	.18
d_{35}	.18	.18	.21	.16	.26	.24	.22	.28	.26	.26	.23
d_{50}	.21	.21	.25	.19	.28	.26	.26	.40	.29	.29	.32
d_{65}	.23	.23	.30	.22	.32	.30	.33	13	.33	.34	18
d_{84}	.31	.33	5.6	.31	1.1	.50	7.4	36	.45	.50	43
d_{90}	.43	7.0	8.0	5.5	12	1.0	15	45	11	10	50
d_{95}	7.8	21	11	45	20	16	22	52	21	18	57

Percent-finer parameter	5-23-79	6-18-79	7-10-79	7-24-79	8-01-79	8-08-79	8-29-79	9-06-79	9-12-79	10-02-79
d_5	0.10	0.12	0.21	0.12	0.15	0.17	0.20	0.20	0.17	0.14
d_{16}	.16	.18	.28	.23	.30	.28	.30	.30	.24	.21
d_{35}	.23	.25	.31	.31	.36	.70	.31	.35	.28	.24
d_{50}	.26	.27	.33	4.8	.40	6.2	.33	.39	.30	.26
d_{65}	.29	.30	.36	9.4	6.2	10.0	2.2	8.0	.33	.28
d_{84}	3.0	.33	7.9	16	17	17	14	15	.37	8.6
d_{90}	9.0	.35	18	21	20	19	18	19	4.0	11
d_{95}	14	.40	27	28	25	21	23	24	12	15

Table 20.--Statistical data for particle-size distribution of bedload sediment, north and south channels, Tanana River near North Pole

[Particle diameter (mm) at given percent-finer parameter]

Percent-finer parameter	North channel										
	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78	10-05-78
d_5	0.13	0.17	0.12	0.08	0.13	0.09	0.13	0.09	0.12	0.14	0.16
d_{16}	.23	.28	.17	.13	.20	.15	.21	.16	.17	.18	.20
d_{35}	4.8	6.5	.23	.17	.35	.21	.40	.22	.24	.27	.26
d_{50}	12	11	.26	.19	7.7	.26	11	.28	.29	.42	.30
d_{65}	19	13	.30	.22	13	.32	19	.34	.34	10	.36
d_{84}	36	19	.37	.28	28	10	33	.60	14	21	2.5
d_{90}	42	24	.42	.31	36	19	41	8.0	23	25	8.5
d_{95}	47	29	32	.36	45	26	50	16	31	28	14

Percent-finer parameter	South channel										
	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78	10-05-78
d_5	0.18	0.14	0.13	0.12	0.14	0.13	0.19	0.20	0.15	0.14	0.14
d_{16}	.28	.23	.19	.17	.25	.23	.35	.48	.25	.16	.16
d_{35}	7.5	.34	.26	.23	5.0	.33	9.4	5.3	5.3	.21	.20
d_{50}	15	5.4	2.3	.26	13	9.5	20	9.0	12	.26	.24
d_{65}	23	12	21	.35	21	19	32	17	19	.30	.28
d_{84}	38	35	28	11	28	34	50	40	31	14	.35
d_{90}	45	42	30	17	31	41	55	49	37	20	.39
d_{95}	48	47	31	25	38	50	60	56	45	26	.46

Percent-finer parameter	North channel								
	6-19-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
d_5	0.18	0.21	0.16	0.26	0.27	0.20	0.19	0.16	0.17
d_{16}	.27	.33	.27	3.8	3.8	.30	.27	.24	.23
d_{35}	.32	6.4	6.0	9.6	14	.34	.34	.28	.26
d_{50}	.35	11	12	14	20	.42	3.3	.32	.27
d_{65}	7	16	16	19	28	7.4	8.4	.38	.28
d_{84}	18	29	27	33	43	16	19	20	.29
d_{90}	23	37	34	41	50	20	32	26	.30
d_{95}	31	47	44	50	56	25	45	29	.32

Percent-finer parameter	South channel								
	6-19-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
d_5	0.14	0.22	0.14	0.11	0.12	0.17	0.16	0.16	0.16
d_{16}	.21	1.0	.26	.19	.21	.27	.22	.23	.23
d_{35}	.26	7.8	.80	.28	.30	.33	.28	.29	.31
d_{50}	.28	12	8.4	.33	.33	5.4	.30	.32	.37
d_{65}	.29	16	19	.36	3.7	14	.50	.45	.74
d_{84}	.30	23	46	8.0	20	21	18	7.8	14
d_{90}	.48	28	53	13	27	26	24	9.4	20
d_{95}	4.0	30	58	19	30	32	29	12	26

Table 21.--Statistical data for particle-size distribution of bedload sediment, composite channels, Tanana River near North Pole

[Particle diameter (mm) at given percent-finer parameter]

Percent-finer parameter	8-04-77	8-19-77	5-31-78	6-21-78	7-11-78	7-18-78	8-01-78	8-09-78	8-15-78	9-08-78
d_5	0.14	0.16	0.12	0.09	0.13	0.12	0.14	0.13	0.12	0.14
d_{16}	.25	.25	.17	.15	.20	.17	.23	.20	.18	.18
d_{35}	6.0	4.8	.23	.20	.44	.25	1.5	.30	.26	.25
d_{50}	13	9.6	.26	.22	8.4	.34	13	1.6	.33	.35
d_{65}	21	13	.32	.26	15	6.6	22	7.4	.50	8.0
d_{84}	37	21	.49	.49	28	24	37	26	22	18
d_{90}	43	28	22	7.6	35	31	45	34	27	22
d_{95}	47	36	31	21	44	40	54	44	31	26

Percent-finer parameter	10-05-78	6-18-79	7-13-79	7-23-79	7-31-79	8-09-79	8-30-79	9-07-79	9-13-79	10-03-79
d_5	0.15	0.17	0.22	0.15	0.18	0.22	0.19	0.17	0.16	0.16
d_{16}	.18	.25	.33	.27	.29	.32	.29	.26	.23	.23
d_{35}	.24	.32	6.8	4.4	4.0	10	.36	.33	.29	.26
d_{50}	.27	.33	11	11	10	17	.58	.41	.32	.27
d_{65}	.31	1.0	16	17	15	25	9.0	7.4	.37	.28
d_{84}	.45	15	27	32	28	43	19	18	13	.30
d_{90}	3.9	21	34	39	38	49	23	26	19	.36
d_{95}	11	28	44	49	48	56	26	39	24	6.0

Table 22.--Composite size distribution (transport-rate weighted) of bedload sediment, Tanana River

(In percent by weight)

Particle size (mm)	1977 Fairbanks Percent retained	1977 Fairbanks Percent finer	1977 North Pole Percent retained	1977 North Pole Percent finer	1978 Fairbanks Percent retained	1978 Fairbanks Percent finer	1978 North Pole Percent retained	1978 North Pole Percent finer	1979 Fairbanks Percent retained	1979 Fairbanks Percent finer	1979 North Pole Percent retained	1979 North Pole Percent finer
128	---	100.0	---	---	---	---	---	---	---	---	---	---
64	0.5	99.5	---	100.0	---	100.0	---	100.0	---	100.0	---	100.0
32	10.5	89.0	16.0	84.0	5.8	94.2	8.9	91.1	1.2	98.8	9.2	90.8
16	24.5	64.5	20.0	64.0	7.0	87.2	16.7	74.4	11.3	87.5	20.9	69.9
8	20.0	44.5	24.0	40.0	5.7	81.5	12.0	62.4	14.4	73.1	20.5	49.4
4	8.0	36.5	6.5	33.5	3.8	77.7	5.6	56.8	6.9	66.2	9.5	39.9
2	1.2	35.3	1.0	32.5	.9	76.8	2.3	54.5	1.8	64.4	2.6	37.2
1.0	.3	35.0	.2	32.3	.4	76.4	.9	53.6	0.7	63.7	0.8	36.5
.5	1.0	34.0	.3	32.0	1.1	75.3	1.1	52.5	1.2	62.5	1.0	35.5
.25	20.0	14.0	16.0	16.0	39.2	36.1	23.2	29.3	44.1	18.4	24.2	11.3
.125	12.5	1.5	13.0	3.0	30.3	5.8	25.2	4.1	15.0	3.4	9.2	2.1
.062	1.0	.5	2.0	1.0	4.4	1.4	3.0	1.1	2.7	0.7	1.6	0.5
<.062	.5	.0	1.0	.0	1.4	.0	1.1	.0	0.7	0	0.5	0

Particle-size statistics

[Particle diameter (mm) at given percent-finer parameter]

Percent-finer parameter	1977 Fairbanks	1977 North Pole	1978 Fairbanks	1978 North Pole	1979 Fairbanks	1979 North Pole
d_{5}	0.18	0.15	0.12	0.13	0.16	0.19
d_{16}	.26	.25	.17	.19	.24	.28
d_{25}	.32	.33	.21	.23	.28	.33
d_{35}	1.0	5.6	.25	.27	.31	.43
d_{50}	10	11	.30	.43	.34	8.2
d_{65}	16	16	.37	9.6	3.0	14
d_{75}	21	22	.50	16	9.0	18
d_{84}	28	32	11	23	14	24
d_{90}	34	40	22	31	18	30
d_{95}	42	46	35	42	23	39

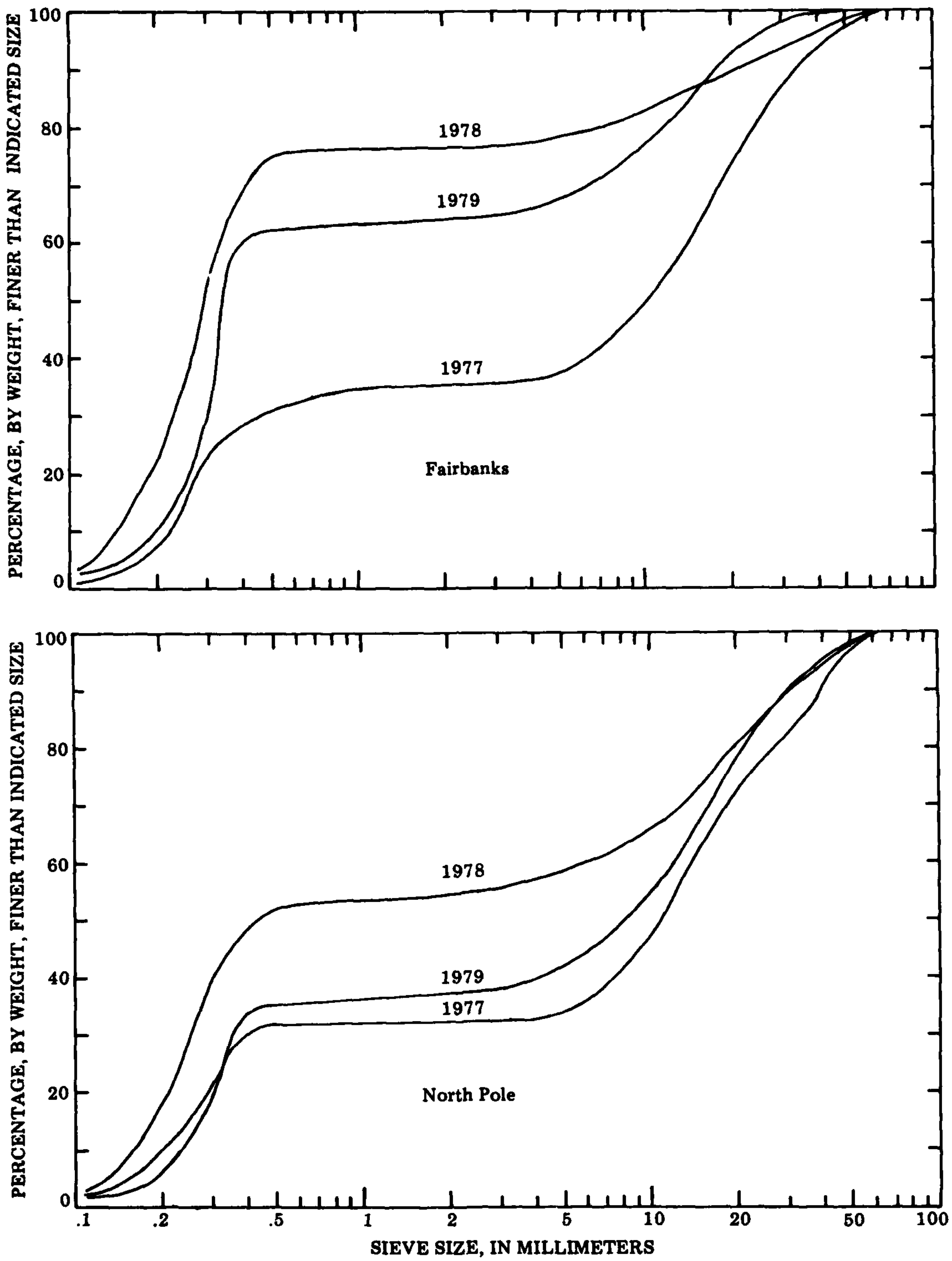

Figure 17.--Particle-size distribution of bedload; comparison of 1977, 1978, and 1979 for Tanana River at Fairbanks, and near North Pole.

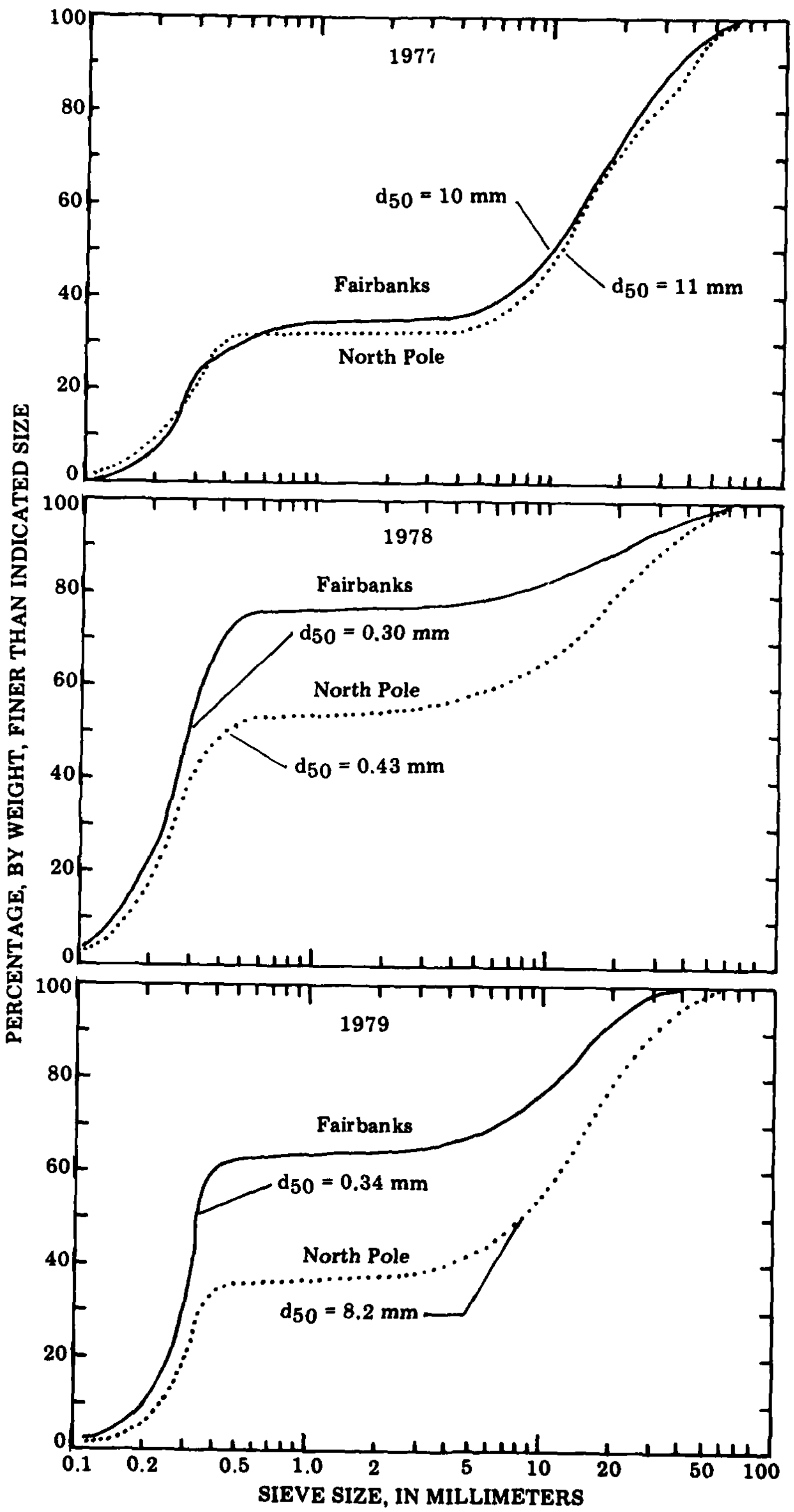

Figure 18.--Particle-size distribution of bedload; comparison of Fairbanks and North Pole, by year.

uniform increments of time over the runoff period. Thus, samples collected at higher transport rates carry more "weight" because their actual weights are greater. It must be noted that the composite size distribution for North Pole in 1977 was based on only two bedload samples.

At Fairbanks in 1977, about 65 percent of the bedload was gravel, while in 1978, only 23 percent was gravel. In 1979 median particle size of bedload at Fairbanks increased, and gravel constituted about 36 percent of total bedload.

Near North Pole, decrease in median particle size was modest; in 1977, about 68 percent of the bedload was gravel, while in 1978, about 45 percent was gravel. In 1979, median particle size increased from the medium sand range to the gravel range, and gravel constituted about 63 percent of total bedload. The increase in coarseness of bedload in 1979 was somewhat greater at the North Pole station than at the Fairbanks station.

Figure 18 is a comparison of size distribution of bedload at North Pole and Fairbanks by year. Assuming that the 1977 North Pole distribution is fairly representative of the bedload in transport for that year, it is apparent that, over the entire size range, the difference in particle size from North Pole to Fairbanks is greater in successive years.

Annual Sediment Loads

Daily mean discharges from tables 2-4 can be arranged in order of magnitude to indicate the number of days during which each discharge is equalled or exceeded. The number of days can then be multiplied by the corresponding sediment-transport rate to provide estimates of amounts of sediment transported by each discharge class. These incremental amounts can then be accumulated through the yearly range of discharges to provide an estimate of the annual sediment load. Computations for sediment loads are provided in tables 23-25 for the location at Fairbanks, for water years 1977, 1978, and 1979 respectively. Tables 27 and 28 contain the same computations for North Pole in 1978 and 1979. (Transport functions were not defined for 1977.)

The cumulative sediment loads are plotted as functions of percentage of time in figures 19 and 20. These computations are based on the water-discharge data for each year as defined at the Fairbanks gaging station and the suspended-sediment- and bedload-sediment-transport rates for each year and each site as previously presented. Total annual loads, in metric tons, are summarized below.

	FAIRBANKS		NORTH POLE	
	Suspended	Bedload	Suspended	Bedload
1977	26,800,000	326,000	---	---
1978	21,200,000	254,000	20,900,000	274,000
1979	27,500,000	440,000	26,700,000	369,000

The same type of computations can be made on an average year basis by using the flow-duration data from the entire station record. Six complete water

Table 23.--Sediment transport in the Tanana River at Fairbanks, water year 1977

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m^3/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
1,760	1	0.3	560,000	---	4,480	---	0.8	560,000	560,000	2.1	4,480	4,480	1.4
1,710	1	.5	516,000	---	4,270	---	0.8	516,000	1,080,000	4.0	4,270	8,750	2.7
1,690	2	1.1	499,000	---	4,180	---	0.8	998,000	2,070,000	7.7	8,360	17,100	5.2
1,680	1	1.4	491,000	---	4,140	---	0.8	491,000	2,560,000	9.6	4,140	21,200	6.5
1,640	1	1.6	459,000	---	3,980	---	0.9	459,000	3,020,000	11.3	3,980	25,200	7.7
1,610	1	1.9	435,000	---	3,850	---	0.9	435,000	3,460,000	12.9	3,850	29,100	8.9
1,590	3	2.7	420,000	---	3,770	---	0.9	1,260,000	4,720,000	17.6	11,300	40,400	12.4
1,560	1	3.0	398,000	---	3,650	---	0.9	398,000	5,120,000	19.1	3,650	44,000	13.5
1,550	1	3.3	391,000	---	3,610	---	0.9	391,000	5,510,000	20.5	3,610	47,600	14.6
1,530	4	4.4	377,000	---	3,530	---	0.9	1,510,000	7,020,000	26.2	14,100	61,700	18.9
1,510	1	4.7	363,000	---	3,450	---	1.0	363,000	7,380,000	27.5	3,450	65,200	20.0
1,500	1	4.9	356,000	---	3,410	---	1.0	356,000	7,740,000	28.9	3,410	68,600	21.0
1,490	2	5.5	350,000	---	3,370	---	1.0	700,000	8,440,000	31.5	6,470	75,300	23.1
1,470	6	7.1	337,000	---	3,300	---	1.0	2,020,000	10,500,000	39.2	19,800	95,100	29.2
1,460	2	7.7	330,000	---	3,260	---	1.0	660,000	11,100,000	41.4	6,520	102,000	31.3
1,440	1	7.9	317,000	---	3,180	---	1.0	317,000	11,400,000	42.5	3,180	105,000	32.2
1,430	2	8.5	311,000	---	3,140	---	1.0	622,000	12,100,000	45.1	6,280	111,000	34.0
1,420	3	9.3	305,000	---	3,110	---	1.0	915,000	13,000,000	48.5	9,330	120,000	36.8
1,410	2	9.9	299,000	---	3,070	---	1.0	598,000	13,600,000	50.7	6,140	127,000	39.0
1,390	4	11.0	287,000	---	3,000	---	1.0	1,150,000	14,700,000	54.9	12,000	139,000	42.6
1,370	4	12.1	276,000	---	2,920	---	1.1	1,100,000	15,800,000	59.0	11,700	150,000	46.0
1,300	12	15.3	238,000	257,000	2,670	2,800	1.1	3,080,000	18,900,000	70.5	33,600	184,000	56.4
1,200	7	17.3	189,000	214,000	2,330	2,500	1.2	1,500,000	20,400,000	76.1	17,500	201,000	61.7
1,100	15	21.4	148,000	168,000	2,010	2,170	1.3	2,520,000	22,900,000	85.4	32,600	234,000	71.8
1,000	4	22.5	113,000	130,000	1,710	1,860	1.4	520,000	23,400,000	87.3	7,440	241,000	73.9
800	12	25.8	60,100	86,600	1,160	1,440	1.7	1,040,000	24,400,000	91.4	17,300	259,000	79.4
600	39	36.4	26,600	43,400	712	936	2.2	1,690,000	26,100,000	97.8	36,500	295,000	90.5
400	19	41.6	8,450	17,500	356	534	3.1	332,000	26,500,000	98.9	10,100	305,000	93.6
200	38	52.1	1,190	4,820	109	232	4.8	183,000	26,700,000	99.6	8,820	314,000	96.3
85	175	100.0	105	648	25	67	---	113,000	26,800,000	100.0	11,700	326,000	100.0

Table 24.--Sediment transport in the Tanana River at Fairbanks, water year 1978

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Equalled or exceeded (m^3/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
1,670	1	0.3	431,000	---	4,200	---	1.0	431,000	431,000	2.0	4,200	4,200	1.7
1,650	2	.8	418,000	---	4,100	---	1.0	836,000	1,270,000	6.0	8,200	12,400	4.9
1,640	2	1.4	412,000	---	4,050	---	1.0	824,000	2,090,000	9.9	8,100	20,600	8.1
1,610	3	2.2	394,000	---	3,910	---	1.0	1,180,000	3,270,000	15.4	11,700	32,200	12.7
1,600	1	2.5	388,000	---	3,860	---	1.0	388,000	3,660,000	17.3	3,860	36,100	14.2
1,590	1	2.7	382,000	---	3,810	---	1.0	323,000	4,040,000	19.1	3,810	39,900	15.7
1,580	1	3.0	376,000	---	3,770	---	1.0	376,000	4,420,000	20.8	3,770	43,600	17.2
1,570	2	3.6	370,000	---	3,720	---	1.0	740,000	5,160,000	24.3	7,440	51,100	20.1
1,550	1	3.8	358,000	---	3,630	---	1.0	358,000	5,520,000	26.0	3,630	54,700	21.5
1,540	3	4.7	353,000	---	3,580	---	1.0	1,060,000	6,580,000	31.0	10,700	65,400	25.7
1,530	2	5.2	347,000	---	3,540	---	1.0	694,000	7,270,000	34.3	7,080	72,500	28.5
1,520	1	5.5	341,000	---	3,490	---	1.0	341,000	7,610,000	35.9	3,490	76,000	29.9
1,500	1	5.8	330,000	---	3,400	---	1.0	330,000	7,940,000	37.5	3,400	79,400	31.3
1,480	2	6.3	320,000	---	3,320	---	1.0	640,000	8,580,000	40.5	6,640	86,000	33.9
1,470	1	6.6	314,000	---	3,270	---	1.0	314,000	8,890,000	41.9	3,270	89,300	35.2
1,440	1	6.8	299,000	---	3,140	---	1.1	299,000	9,190,000	43.3	3,140	92,400	36.4
1,420	2	7.4	289,000	---	3,060	---	1.1	578,000	9,770,000	46.1	6,120	98,600	38.8
1,390	3	8.2	274,000	---	2,930	---	1.1	822,000	10,600,000	50.0	8,790	107,000	42.1
1,380	1	8.5	269,000	---	2,890	---	1.1	269,000	10,900,000	51.4	2,890	110,000	43.3
1,370	1	8.8	264,000	---	2,850	---	1.1	264,000	11,100,000	52.4	2,850	113,000	44.5
1,360	1	9.0	259,000	---	2,810	---	1.1	259,000	11,400,000	53.8	2,810	116,000	45.7
1,300	8	11.2	232,000	246,000	2,570	2,690	1.1	1,970,000	13,400,000	63.2	21,500	137,000	53.9
1,200	3	12.1	190,000	211,000	2,200	2,380	1.1	633,000	14,000,000	66.0	7,140	145,000	57.1
1,100	2	12.6	154,000	172,000	1,860	2,030	1.2	344,000	14,300,000	67.5	4,060	149,000	58.7
1,000	6	14.2	121,000	138,000	1,540	1,700	1.2	828,000	15,200,000	71.7	10,200	159,000	62.6
800	24	20.8	70,000	95,500	998	1,270	1.3	2,290,000	17,400,000	82.1	30,500	189,000	74.4
600	39	31.5	34,400	52,200	569	784	1.5	2,040,000	19,500,000	92.0	30,600	220,000	86.6
400	56	46.8	12,600	23,500	258	414	1.8	1,320,000	20,800,000	98.1	23,200	243,000	95.7
200	28	54.4	2,280	7,440	67	162	2.2	208,000	21,000,000	99.1	4,540	248,000	97.6
85	166	100.0	276	1,280	13	40	---	212,000	21,200,000	100.0	6,640	254,000	100.0

Table 25.--Sediment transport in the Tanana River at Fairbanks, water year 1979

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m³/s)	Number of days	Number of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
2,120	1	0.2	564,000	---	4,100	---	0.7	564,000	564,000	2.1	4,100	4,100	0.9
2,100	1	.5	551,000	---	4,060	---	.7	551,000	1,120,000	4.1	4,060	8,160	1.9
2,080	1	.8	537,000	---	4,020	---	.7	537,000	1,650,000	6.0	4,020	12,200	2.8
2,060	1	1.0	524,000	---	3,980	---	.8	524,000	2,180,000	7.9	3,980	16,200	3.7
2,040	1	1.3	511,000	---	3,950	---	.8	511,000	2,690,000	9.8	3,950	20,100	4.6
2,020	3	2.1	498,000	---	3 910	---	.8	1,490,000	4,180,000	15.2	11,700	31,800	7.2
2,000	3	3.0	486,000	---	3,870	---	.8	1,460,000	5,640,000	20.2	11,600	43,400	9.9
1,980	1	3.2	474,000	---	3,830	---	.8	474,000	6,110,000	22.2	3,830	47,200	10.7
1,940	2	3.8	449,000	---	3,760	---	.8	898,000	7,010,000	25.5	7,520	54,800	12.5
1,920	1	4.1	438,000	---	3,720	---	.8	438,000	7,450,000	27.1	3,720	58,500	13.3
1,900	2	4.7	426,000	---	3,680	---	.9	852,000	8,300,000	30.2	7,360	65,800	15.0
1,880	1	4.9	415,000	---	3,640	---	.9	415,000	8,710,000	31.7	3,640	69,500	15.8
1,860	1	5.2	403,000	---	3,610	---	.9	403,000	9,120,000	33.2	3,610	73,100	16.6
1,840	1	5.5	392,000	---	3,570	---	.9	392,000	9,510,000	34.6	3,570	76,700	17.4
1,820	1	5.8	382,000	---	3,530	---	.9	382,000	9,890,000	36.0	3,530	80,200	18.2
1,800	6	7.4	371,000	---	3,490	---	.9	2,230,000	12,100,000	44.0	20,900	101,000	23.0
1,750	6	9.0	345,000	358,000	3,400	3,440	1.0	2,150,000	14,300,000	52.0	20,600	122,000	27.7
1,650	2	9.6	297,000	321,000	3,210	3,300	1.0	642,000	14,900,000	54.2	6,600	128,000	29.1
1,600	4	10.7	274,000	286,000	3,110	3,160	1.1	1,140,000	16,100,000	58.5	12,600	141,000	32.0
1,500	3	11.5	232,000	253,000	2,920	3,020	1.2	759,000	16,800,000	61.1	9,060	150,000	34.1
1,400	16	15.9	195,000	214,000	2,730	2,820	1.3	3,420,000	20,200,000	73.5	45,100	195,000	44.3
1,300	6	17.5	161,000	178,000	2,540	2,640	1.5	1,070,000	21,300,000	77.5	15,800	211,000	48.0
1,200	5	18.9	131,000	146,000	2,350	2,440	1.7	730,000	22,000,000	80.0	12,200	223,000	50.7
1,100	10	21.6	105,000	118,000	2,160	2,260	1.9	1,180,000	23,200,000	84.4	22,600	245,000	55.9
1,000	14	25.5	82,200	93,600	1,970	2,060	2.2	1,310,000	24,500,000	89.1	28,800	274,000	62.3
800	28	33.2	46,400	64,300	1,580	1,780	2.8	1,800,000	26,300,000	95.6	49,800	324,000	73.6
600	19	38.4	22,200	34,300	1,190	1,380	4.0	652,000	27,000,000	98.2	26,200	350,000	79.5
400	20	43.8	7,840	15,000	804	997	6.6	300,000	27,300,000	99.3	19,900	370,000	84.1
200	31	52.3	1,330	4,580	408	606	13.2	142,000	27,400,000	99.6	18,800	389,000	88.4
85	174	100.0	148	739	177	292	---	129,000	27,500,000	100.0	50,800	440,000	100.0

Table 26.--Average annual sediment transport in the Tanana River at Fairbanks water years 1974-79

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m^3/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
2,120	1	---	764,000	---	5,330	---	0.7	127,000	127,000	0.5	888	888	0.3
2,100	1	---	745,000	---	5,260	---	0.7	124,000	251,000	1.0	877	1,760	.5
2,080	1	0.1	727,000	---	5,180	---	0.7	121,000	372,000	1.6	863	2,630	.8
2,060	1	.1	708,000	---	5,100	---	0.7	118,000	490,000	2.0	850	3,480	1.1
2,040	1	.2	690,000	---	5,030	---	0.7	115,000	605,000	2.5	838	4,320	1.3
2,020	3	.3	673,000	---	4,950	---	0.7	337,000	942,000	3.9	2,480	6,800	2.1
2,000	3	.5	655,000	---	4,880	---	0.7	327,000	1,270,000	5.3	2,440	9,240	2.9
1,980	1	.5	638,000	---	4,800	---	0.8	106,000	1,380,000	5.8	800	10,000	3.1
1,940	2	.6	605,000	---	4,660	---	0.8	201,000	1,580,000	6.6	1,550	11,600	3.6
1,920	1	.7	588,000	---	4,580	---	0.8	98,000	1,670,000	7.0	763	12,300	3.8
1,900	3	.8	572,000	---	4,510	---	0.8	286,000	1,960,000	8.2	2,260	14,600	4.5
1,880	1	.9	556,000	---	4,440	---	0.8	92,700	2,050,000	8.5	740	15,300	4.8
1,860	2	1.0	541,000	---	4,370	---	0.8	180,000	2,230,000	9.3	1,460	16,800	5.2
1,840	2	1.0	526,000	---	4,300	---	0.8	175,000	2,410,000	10.0	1,430	18,200	5.7
1,820	1	1.1	511,000	---	4,230	---	0.8	85,200	2,490,000	10.4	705	18,900	5.9
1,800	6	1.4	496,000	---	4,160	---	0.8	497,000	2,990,000	12.5	4,160	23,100	7.2
1,750	10	1.8	460,000	478,000	3,980	4,070	0.9	797,000	3,790,000	15.8	6,780	29,900	9.3
1,700	7	2.1	426,000	443,000	3,810	3,900	0.9	517,000	4,300,000	17.9	4,500	34,400	10.7
1,600	28	3.4	363,000	394,000	3,470	3,640	0.9	1,830,000	6,140,000	25.6	17,000	51,400	16.0
1,500	41	5.3	306,000	334,000	3,150	3,310	1.0	2,280,000	8,420,000	35.1	22,600	74,000	23.1
1,400	85	9.2	255,000	280,000	2,830	2,990	1.1	3,970,000	12,400,000	51.7	42,400	116,000	36.1
1,300	82	12.9	210,000	232,000	2,530	2,680	1.2	3,170,000	15,600,000	65.0	36,600	153,000	47.7
1,200	50	15.2	170,000	190,000	2,240	2,380	1.3	1,580,000	17,100,000	71.2	19,800	173,000	53.9
1,100	72	18.5	135,000	152,000	1,960	2,100	1.4	1,820,000	19,000,000	79.2	25,200	198,000	61.7
1,000	55	21.0	105,000	120,000	1,700	1,830	1.5	1,100,000	20,100,000	83.8	16,800	215,000	67.0
800	143	27.5	58,200	81,600	1,210	1,460	1.8	1,950,000	22,000,000	91.7	34,800	250,000	77.9
600	159	34.8	27,200	42,700	779	995	2.3	1,130,000	23,100,000	96.2	26,400	276,000	86.0
400	173	42.7	9,310	18,200	420	600	3.3	525,000	23,700,000	98.8	17,300	293,000	91.3
200	265	54.8	1,490	5,400	146	283	5.2	238,000	23,900,000	99.6	12,500	306,000	95.3
85	991	100.0	155	822	40	93	---	136,000	24,000,000	100.0	15,400	321,000	100.0

Table 27.--Sediment transport in the Tanana River near North Pole, water year 1978

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m³/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
1,670	1	0.3	479,000	---	4,460	---	0.9	479,000	479,000	2.3	4,460	4,460	1.6
1,650	2	.8	463,000	---	4,360	---	.9	926,000	1,400,000	6.7	8,720	13,200	4.8
1,640	2	1.4	455,000	---	4,310	---	.9	910,000	2,320,000	11.1	8,620	21,800	8.0
1,610	3	2.2	432,000	---	4,160	---	1.0	1,300,000	3,620,000	17.3	12,500	34,300	12.5
1,600	1	2.5	424,000	---	4,110	---	1.0	424,000	4,040,000	19.3	4,110	38,400	14.0
1,590	1	2.7	417,000	---	4,060	---	1.0	417,000	4,460,000	21.3	4,060	42,500	15.5
1,580	1	3.0	410,000	---	4,010	---	1.0	410,000	4,870,000	23.3	4,010	46,500	17.0
1,570	2	3.6	402,000	---	3,960	---	1.0	804,000	5,670,000	27.1	7,920	54,400	19.9
1,550	1	3.8	388,000	---	3,860	---	1.0	388,000	6,060,000	29.0	3,860	58,300	21.3
1,540	3	4.7	381,000	---	3,810	---	1.0	1,140,000	7,200,000	34.4	11,400	69,700	25.4
1,530	2	5.2	374,000	---	3,770	---	1.0	748,000	7,950,000	38.0	7,540	77,200	28.2
1,520	1	5.5	367,000	---	3,720	---	1.0	367,000	8,310,000	39.8	3,720	80,900	29.5
1,500	1	5.8	353,000	---	3,630	---	1.0	353,000	8,670,000	41.5	3,630	84,600	30.9
1,480	2	6.3	340,000	---	3,540	---	1.0	680,000	9,350,000	44.7	7,080	91,600	33.4
1,470	1	6.6	334,000	---	3,490	---	1.0	334,000	9,680,000	46.3	3,490	95,100	34.7
1,440	1	6.8	315,000	---	3,350	---	1.1	315,000	10,000,000	47.8	3,350	98,500	35.9
1,420	2	7.4	302,000	---	3,260	---	1.1	604,000	10,600,000	50.7	6,520	105,000	38.3
1,390	3	8.2	285,000	---	3,130	---	1.1	855,000	11,500,000	55.0	9,390	114,000	41.6
1,380	1	8.5	279,000	---	3,090	---	1.1	279,000	11,700,000	56.0	3,090	117,000	42.7
1,370	1	8.8	273,000	---	3,050	---	1.1	273,000	12,000,000	57.4	3,050	121,000	44.2
1,360	1	9.0	268,000	---	3,000	---	1.1	268,000	12,300,000	58.9	3,000	124,000	45.3
1,300	8	11.2	235,000	252,000	2,760	2,880	1.1	2,020,000	14,300,000	68.4	23,000	147,000	53.6
1,200	3	12.1	187,000	211,000	2,360	2,560	1.2	633,000	14,900,000	71.3	7,680	154,000	56.2
1,100	2	12.6	146,000	166,000	2,000	2,180	1.3	322,000	15,200,000	72.7	4,360	159,000	58.0
1,000	6	14.2	112,000	129,000	1,660	1,830	1.4	774,000	16,000,000	76.6	11,000	170,000	62.0
800	24	20.8	59,300	85,600	1,080	1,370	1.6	2,050,000	18,100,000	86.6	32,900	202,000	73.7
600	39	31.5	26,200	42,800	624	862	2.0	1,670,000	19,700,000	94.3	33,600	236,000	86.1
400	56	46.8	8,280	17,200	286	455	2.6	963,000	20,700,000	99.0	25,500	262,000	95.6
200	28	54.5	1,160	4,720	76	181	3.8	132,000	20,800,000	99.5	5,070	267,000	97.4
85	166	100.0	102	631	15	46	---	105,000	20,900,000	100.0	7,640	274,000	100.0

Table 28.--Sediment transport in the Tanana River near North Pole, water year 1979

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m³/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
2,120	1	0.2	573,000	---	5,580	---	1.0	573,000	573,000	2.1	5,580	5,580	1.5
2,100	1	.5	559,000	---	5,490	---	1.0	559,000	1,130,000	4.2	5,490	11,100	3.0
2,080	1	.8	544,000	---	5,390	---	1.0	544,000	1,680,000	6.3	5,390	16,500	4.5
2,060	1	1.0	530,000	---	5,300	---	1.0	530,000	2,210,000	8.3	5,300	21,800	5.9
2,040	1	1.3	516,000	---	5,210	---	1.0	516,000	2,720,000	10.2	5,210	27,000	7.3
2,020	3	2.1	503,000	---	5,120	---	1.0	1,510,000	4,230,000	15.8	15,400	42,400	11.5
2,000	3	3.0	489,000	---	5,030	---	1.0	1,470,000	5,700,000	21.3	15,100	57,500	15.6
1,980	1	3.2	476,000	---	4,940	---	1.0	476,000	6,180,000	23.1	4,940	62,400	16.9
1,940	2	3.8	451,000	---	4,770	---	1.1	902,000	7,080,000	26.5	9,540	72,000	19.5
1,920	1	4.1	438,000	---	4,680	---	1.1	438,000	7,520,000	28.2	4,680	76,600	20.8
1,900	2	4.7	426,000	---	4,590	---	1.1	852,000	8,370,000	31.3	9,180	85,800	23.3
1,880	1	4.9	414,000	---	4,510	---	1.1	414,000	8,780,000	32.9	4,510	90,300	24.5
1,860	1	5.2	402,000	---	4,420	---	1.1	402,000	9,190,000	34.4	4,420	94,700	25.7
1,840	1	5.5	390,000	---	4,340	---	1.1	390,000	9,580,000	35.9	4,340	99,100	26.9
1,820	1	5.8	379,000	---	4,260	---	1.1	379,000	9,960,000	37.3	4,260	103,000	27.9
1,800	6	7.4	368,000	---	4,170	---	1.1	2,210,000	12,200,000	45.7	25,000	128,000	34.7
1,750	6	9.0	341,000	354,000	3,970	4,070	1.1	2,120,000	14,300,000	53.6	24,400	153,000	41.5
1,650	2	9.6	290,000	316,000	3,580	3,780	1.2	632,000	14,900,000	55.8	7,560	160,000	43.4
1,600	4	10.7	267,000	278,000	3,390	3,480	1.3	1,110,000	16,000,000	59.9	13,900	174,000	47.2
1,500	3	11.5	224,000	246,000	3,020	3,200	1.3	788,000	16,800,000	62.9	9,600	184,000	49.9
1,400	16	15.9	186,000	205,000	2,670	2,840	1.4	3,280,000	20,100,000	75.3	45,400	229,000	62.1
1,300	6	17.5	152,000	169,000	2,340	2,500	1.5	1,010,000	21,100,000	79.0	15,000	244,000	66.1
1,200	5	18.9	122,000	137,000	2,030	2,180	1.6	685,000	21,800,000	81.6	10,900	255,000	69.1
1,100	10	21.6	96,700	109,000	1,740	1,880	1.7	1,090,000	22,900,000	85.8	18,800	274,000	74.3
1,000	14	25.5	74,700	85,700	1,470	1,600	1.9	1,200,000	24,000,000	89.9	22,400	296,000	80.2
800	28	33.2	40,800	57,800	990	1,230	2.1	1,620,000	25,700,000	96.3	34,400	331,000	89.7
600	19	38.4	18,700	29,800	595	792	2.7	566,000	26,300,000	98.5	15,000	346,000	93.8
400	20	43.8	6,200	12,400	290	442	3.6	248,000	26,500,000	99.3	8,840	355,000	96.2
200	31	52.3	948	3,570	85	187	5.2	111,000	26,600,000	99.6	5,800	360,000	97.6
85	174	100.0	93	520	19	52	---	90,500	26,700,000	100.0	9,050	369,000	100.0

Table 29.--Average annual sediment transport in the Tanana River near North Pole, water years 1974-79

(Mg = metric tons or megagrams)

			SEDIMENT-TRANSPORT RATE					SEDIMENT LOADS					
			Suspended		Bedload			Suspended			Bedload		
Discharge equalled or exceeded (m^3/s)	Number of days	Percentage of time	Equalled or exceeded (Mg/d)	Average (Mg/d)	Equalled or exceeded (Mg/d)	Average (Mg/d)	Ratio of average bedload to average suspended (percent)	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load	Increment (Mg)	Cumulative (Mg)	Cumulative percentage of annual load
2,120	1	---	661,000	---	5,900	---	0.9	110,000	110,000	0.5	983	983	0.3
2,100	1	---	645,000	---	5,800	---	.9	108,000	218,000	1.1	967	1,950	0.7
2,080	1	0.1	629,000	---	5,700	---	.9	105,000	323,000	1.6	950	2,900	1.0
2,060	1	.1	613,000	---	5,600	---	.9	102,000	425,000	2.1	933	3,830	1.3
2,040	1	.2	597,000	---	5,500	---	.9	99,500	524,000	2.5	917	4,750	1.6
2,020	3	.3	582,000	---	5,410	---	.9	291,000	816,000	3.9	2,700	7,460	2.5
2,000	3	.5	567,000	---	5,310	---	.9	284,000	1,100,000	5.3	2,660	10,100	3.4
1,980	1	.5	552,000	---	5,220	---	1.0	92,000	1,190,000	5.7	870	11,000	3.7
1,940	2	.6	523,000	---	5,030	---	1.0	174,000	1,370.000	6.6	1,680	12,700	4.3
1,920	1	.7	509,000	---	4,940	---	1.0	84,800	1,450,000	7.0	823	13,500	4.5
1,900	3	.8	495,000	---	4,850	---	1.0	248,000	1,700,000	8.2	2,420	15,900	5.4
1,880	1	.9	481,000	---	4,760	---	1.0	80,200	1,780,000	8.6	793	16,700	5.6
1,860	2	1.0	468,000	---	4,670	---	1.0	156,000	1,930,000	9.3	1,560	18,300	6.2
1,840	2	1.0	454,000	---	4,580	---	1.0	151,000	2,090,000	10.1	1,530	19,800	6.7
1,820	1	1.1	441,000	---	4,490	---	1.0	73,500	2,160,000	10.4	748	20,500	6.9
1,800	6	1.4	429,000	---	4,400	---	1.0	429,000	2,590,000	12.5	4,400	24,900	8.4
1,750	10	1.8	398,000	---	4,180	---	1.0	663,000	3,250,000	15.7	6,970	31,900	10.7
1,700	7	2.1	368,000	383,000	3,970	4,080	1.1	447,000	3,700,000	17.9	4,760	36,700	12.4
1,600	28	3.4	314,000	341,000	3,560	3,760	1.1	1,590,000	5,290,000	25.6	17,500	54,200	18.2
1,500	41	5.3	264,000	289,000	3,180	3,370	1.2	1,970,000	7,260,000	35.1	23,000	77,200	26.0
1,400	85	9.2	220,000	242,000	2,810	3,000	1.2	3,430,000	10,700,000	51.7	42,500	120,000	40.4
1,300	82	12.9	181,000	200,000	2,460	2,640	1.3	2,730,000	13,400,000	64.7	36,100	156,000	52.5
1,200	50	15.2	146,000	164,000	2,130	2,300	1.4	1,370,000	14,800,000	71.5	19,200	175,000	58.9
1,100	72	18.5	116,000	131,000	1,820	1,980	1.5	1,570,000	16,400,000	79.2	23,800	199,000	67.0
1,000	55	21.0	90,300	103,000	1,540	1,680	1.6	944,000	17,300,000	83.6	15,400	214,000	72.1
800	143	27.5	50,000	70,200	1,030	1,280	1.8	1,670,000	19,000,000	91.8	30,500	245,000	82.5
600	159	34.8	23,300	36,600	616	823	2.2	970,000	19,900,000	96.1	21,800	266,000	89.6
400	173	42.7	7,960	15,600	298	457	2.9	450,000	20,400,000	98.6	13,200	280,000	94.3
200	265	54.8	1,270	4,620	86	192	4.2	204,000	20,600,000	99.5	8,480	288,000	97.0
85	991	100.0	131	700	19	52	---	116,000	20,700,000	100.0	8,590	297,000	100.0

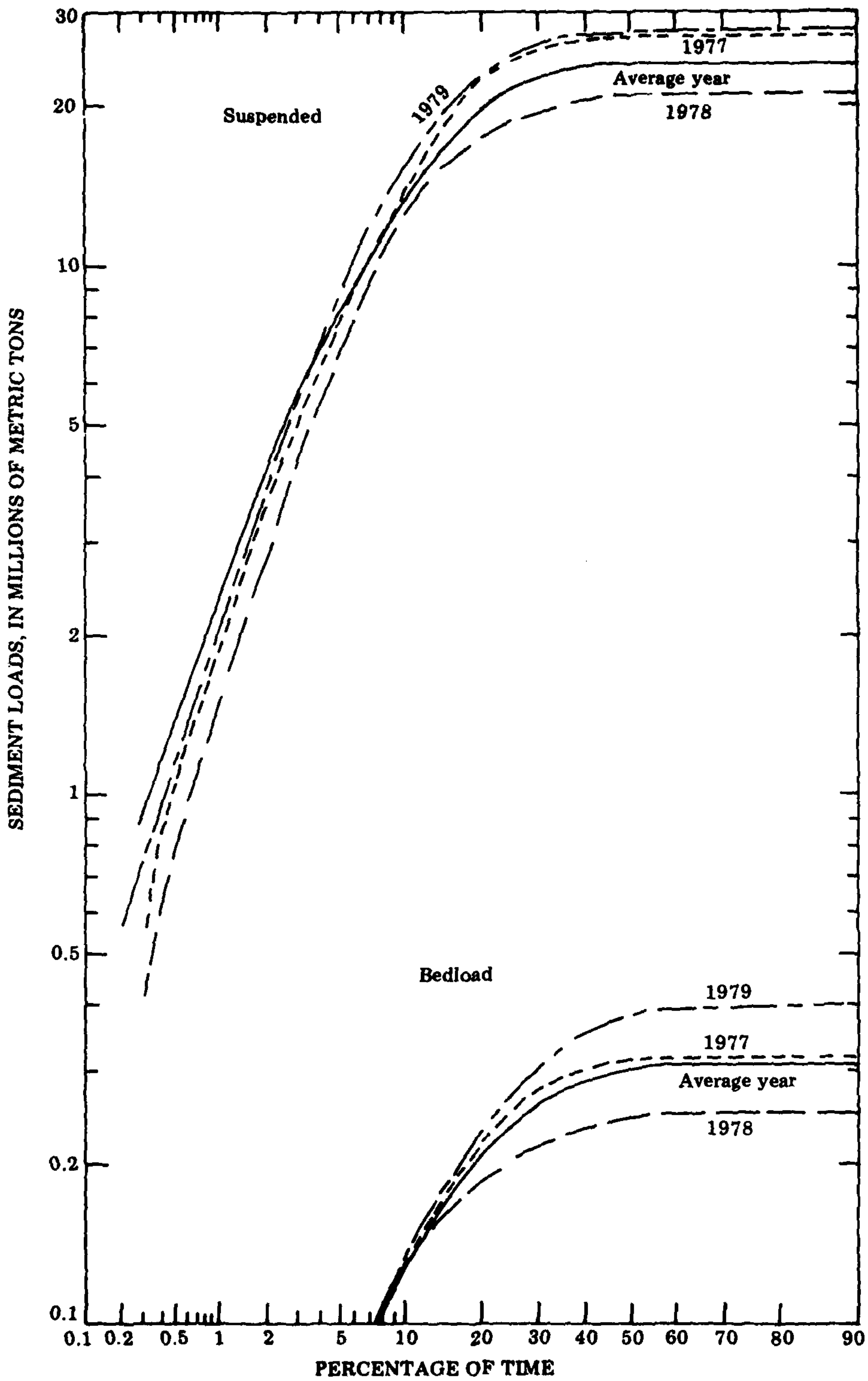

Figure 19.--Cumulative sediment loads, Tanana River at Fairbanks, as a function of percentage of time, 1977, 1978, 1979, and for an average year (1974-1979).

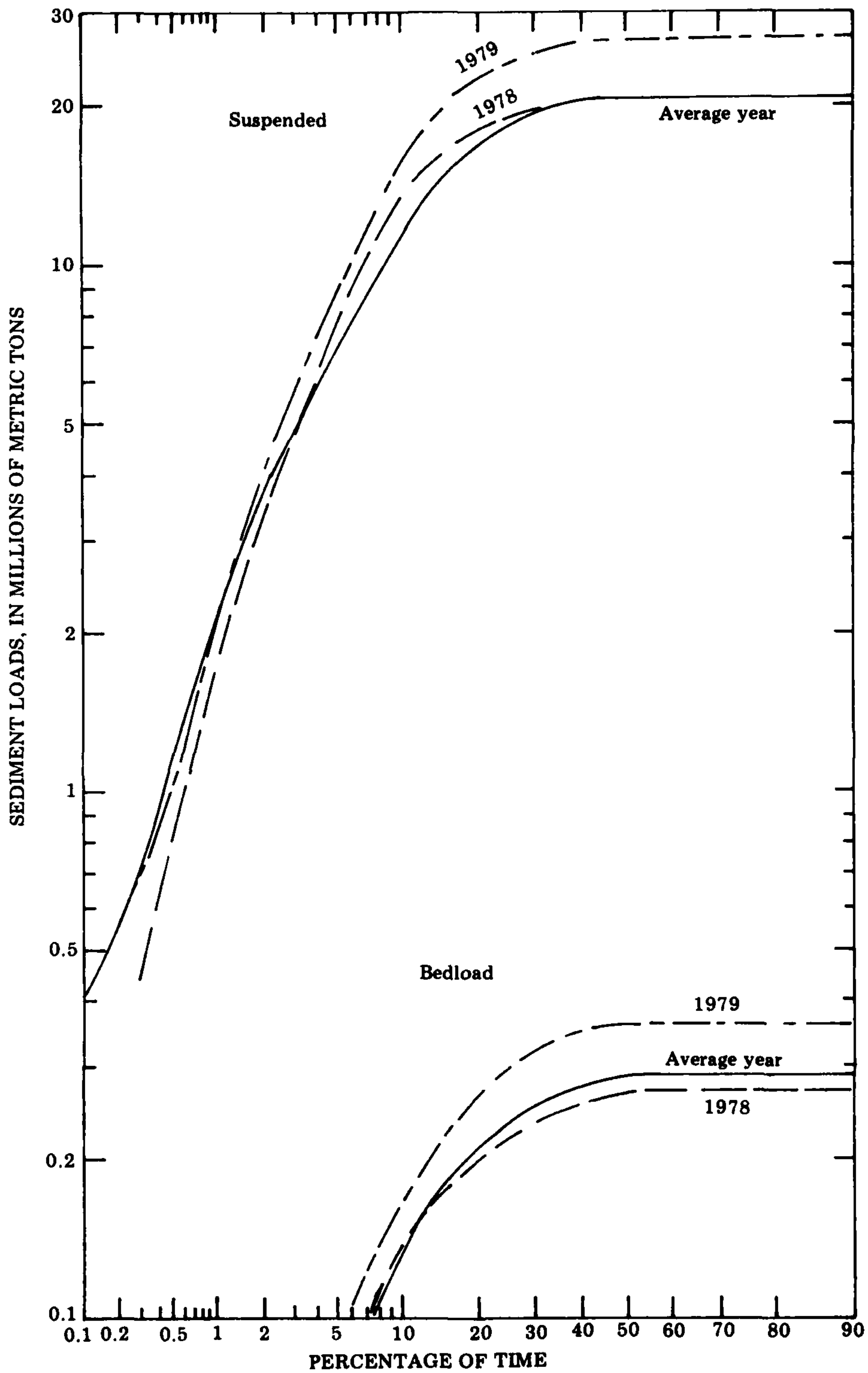

Figure 20.--Cumulative sediment loads, Tanana River near North Pole as,a function of percentage of time, 1978, 1979, and for an average year (1974-1979).

years of data (1974-1979) exist for the Tanana River at Fairbanks. These are the basis for the flow-duration data and subsequent computations of average annual sediment loads listed in tables 26 and 29 and graphed in figures 19 and 20. Based on these 6 years of record, average annual suspended-sediment load of the Tanana River at Fairbanks is about 24 million metric tons and near North Pole, 20.7 million metric tons.

Bedload averages 321,000 metric tons at Fairbanks and 297,000 metric tons near North Pole. These values were determined using the transport functions defined by all the sediment data (1977-79) for each location.

For the 6 complete years of record, annual mean discharge of the Tanana River ranged from 475 m^3/s to 613 m^3/s and averaged 540 m^3/s. In 1977, 1978 and 1979 the annual mean discharge of the Tanana River at Fairbanks was 537 m^3/s, 506 m^3/s, and 610 m^3/s respectively. The above values of annual water discharge and sediment load suggest that annual suspended-sediment loads in the Tanana River are on the order of 18 - 30 million metric tons. Assuming, for simplicity, a unit weight of suspended sediment of 1,000 kg/m^3 (Guy, 1970), about 18 - 30 million m^3 of suspended sediment are transported annually. Annual total bedload would be 250,000 - 450,000 metric tons. If we take the unit weight of bedload to be 1,600 kg/m^3 (Guy, 1970), then 155,000 - 280,000 m^3 of bedload are transported annually.

Annual bedloads shown are between 1 and 1.5 percent of the suspended-sediment load. The average bedload-transport rate expressed as a percentage of average suspended-sediment-transport rate ranges from less than 1 percent at highest flows to about 10 percent at low flows (column 8 in tables 23-29). No percentage is shown for flows less than 200 m^3/s; the bedload-transport functions are extrapolated to define the transport rates at much lower flows than at which bedload data have been collected. High ratios of bedload- to suspended-sediment-transport rate at very low flows, as indicated by the transport functions, may not actually occur. This does not greatly affect the annual load computations, because most of the transport occurs at higher flows.

Eighty percent of the bedload is transported during about 30 percent of the year at flows exceeding 600 m^3/s. More than half of the suspended-sediment load is transported in about 10 percent of the year at flows greater than 1,300 m^3/s.

The differences in the computed annual loads between Fairbanks and North Pole are entirely due to the differences in the transport functions defined for each location, as the water discharge data are the same. There were 300,000 and 800,000 more metric tons of suspended sediment transported past Fairbanks in 1978 and 1979 respectively than near North Pole. There were 20,000 metric tons more bedload transported past North Pole than Fairbanks in 1978, but 71,000 metric tons less in 1979. For the suspended-sediment and total loads these are relatively small differences considering the overall amounts of material transported. However, for the average year defined by the 1977-79 data for each site, 3.3 million metric tons more sediment pass Fairbanks than North Pole.

In 1977, 58,000, in 1978, 52,000, and in 1979, 43,000 m^3 of bed material were quarried from the Tanana River between North Pole and Fairbanks. This amounts to about 93,000, 83,000, and 69,000 metric tons respectively. In addition to the mining of gravel between the two locations, during the winter of 1978-79 the Corps of Engineers constructed an L-shaped dike in the river 1 km upstream of the North Pole sampling site. This involved the removal of 46,000 m^3 of material for building the dike. The channel was also disturbed by the construction of a temporary in-river diversion composed of waste material. This diversion structure was partly eroded during the 1979 runoff season. The effects of these activities on transport rates and particle size of transported sediment can be only speculated. However, overall quantities of material quarried from the river bed were less than 1 percent of the sediment transported by the river.

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